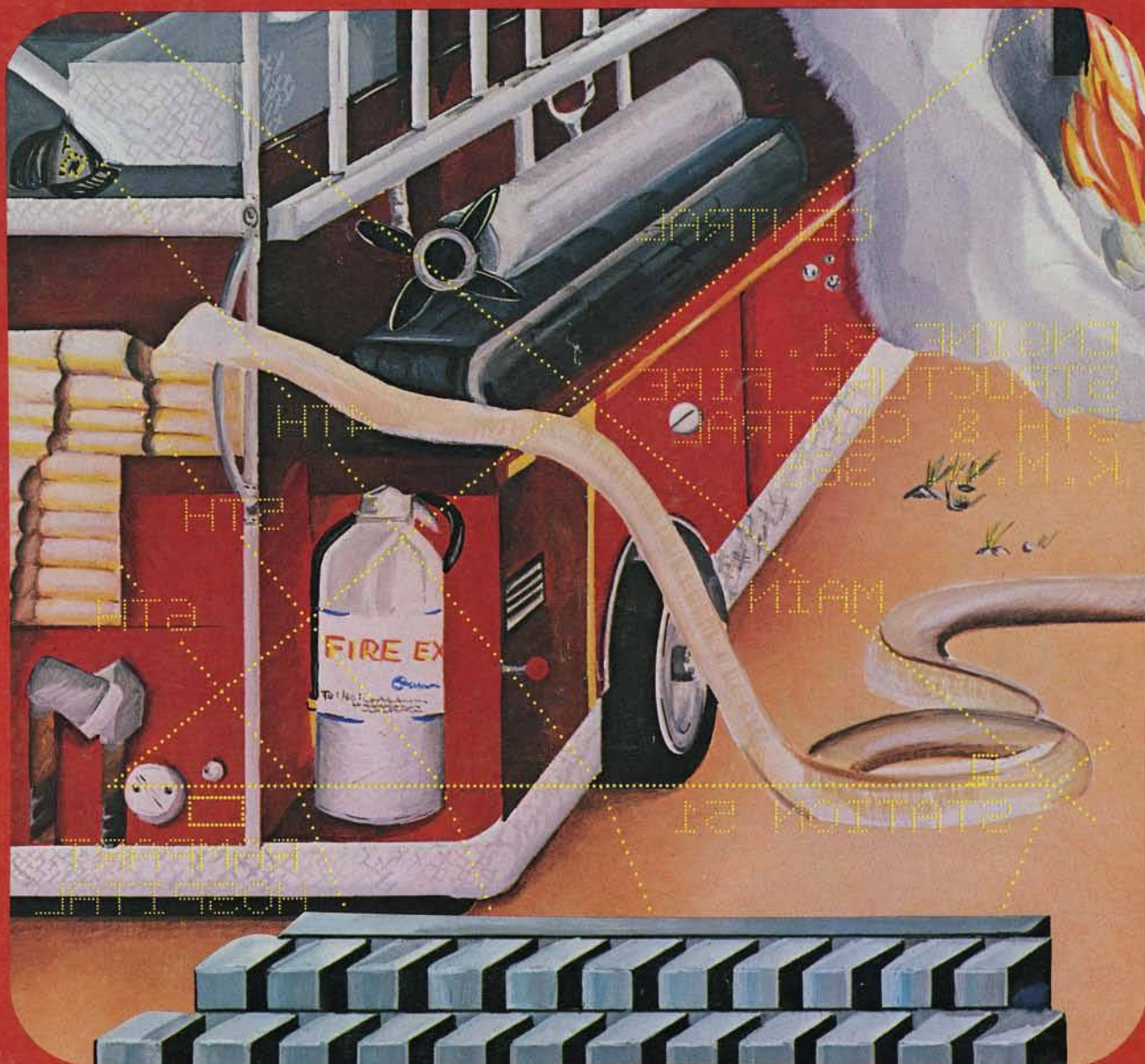


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A MICRO Potpourri

While cleaning out my desk, as part of adding office space to MICRO, I uncovered a vast cache of notes that I had written to myself: little things which I wanted to pass on to MICRO's readers.

Canadian Mail: There seem to be problems with the Canadian mail service. In recent months we have been receiving more reports of non-delivery from our northern neighbors than from all of the US subscribers. We hope that the service gets better, and for now can only counsel patience. If your magazine does not reach you by the middle of the month, then complain to your postal service.

Mailing Date: MICRO is always in the mail before the first of the issue month. The actual mailing date varies as a function of the month, but is generally between the 24th and 28th. The Second Class mail, in the US, is *supposed* to get to all points within a week.

Limerick Contest: Since I have been declared ineligible by my staff to officially enter the **MICRO** limerick contest [a most unfair rule I think], I am going to exercise editorial prerogative, if not editorial judgment, and present it here!

*A clever programmer named Mike Rowe,
Said, "I get double use from each MICRO.
First I learn what to do
With my Sixty-Five-Oh-Two,
Then I use it to paper train my crow!*

[Now, don't you just *know* that you can do better than that? Only a few weeks left to get your entry in.]

Mike Rowe: The first issue of **MICRO**, in October 1977, contained the following 'biographical' notes about Mike Rowe: 'He prefers hexadecimal notation since he has eight fingers on each hand', and is a 'Computer consultant for the Starship Enterprise'. Apparently some readers missed the first issue, and/or have never said the name out loud and discovered the hidden meaning. Mike Rowe is, of course, the name used to indicate that an article has been prepared by one or more members of the MICRO Staff from material supplied by others. The Software Catalog is an example. We have been surprised at the amount of mail we get addressed to Mike Rowe. Since 1977 we have discovered at least three others: Michael Roe — a subscriber; Mike Rowe Productions — also a

subscriber; and Mike Rowe who, according to the newspaper, is the best stock car driver in Maine. If you happen to know of any other 'Mike Rowe', we would like to hear about him.

MICRO Advertising and Advertisers: Advertising is very important to MICRO for two reasons: first, it provides some very important and timely information about what is available, and, second, it supports the magazine. The reason that MICRO has been able to grow from 28 to 84 pages, has been due to the terrific support of the advertisers. We hope this will continue to grow. You can help. All it takes is informing an advertiser that you 'Saw it in MICRO'. That's all. Advertisers do not generally have any simple way to determine the effectiveness of a particular ad. Feedback from the buying public is the most effective way of telling an advertiser that his ad is working. So, when you place an order, please mention MICRO.

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Writing for MICRO: MICRO pays top rates for articles. If you have good 6502 related ideas, programs, etc., consider writing about them for MICRO. We have prepared a **MICRO Writer's Guide** to help. For your copy, simply send a self-addressed [we'll provide the stamp] envelope requesting the guide.

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Robert M. Trip



Emergency MICRO

Cover Artist

Terry Spillane

Graphic Data Retrieval Systems

This month's cover shows one type of Graphic Data Retrieval System: a fire department system to keep track of the equipment available for meeting various emergency conditions. While the concept is not new or specific to micros, it is a technique which can have broad application and which is quite suited to the display oriented microcomputers.

A GDRS basically combines graphic data, such as a map, with alphanumeric data. In the cover example, a map of the section of the city which contains an emergency condition, in this case a fire, is displayed to quickly show the operator the locations of relevant resources: a fire station, hospital, police, ambulance, etc. The status of each potential resource is given as alphanumeric information. As the operation progresses, this information can be continually updated either manually via a keyboard or, in a fancy system, automatically via various devices which would track the vehicles.

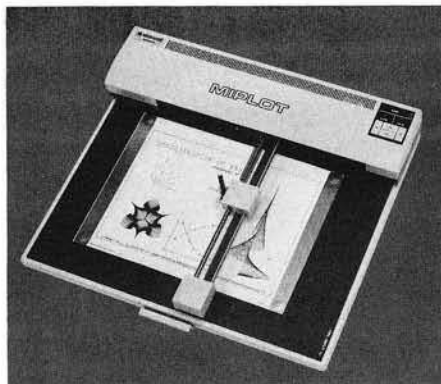
This is a very dramatic example of the technique. Many other less dramatic but nonetheless important uses can be conceived for GDRS technique. The flow of material through any process, from an oil pipe line to a auto production facility, can be tracked and displayed. The operator can 'zoom in' on any particular part of the operation which is of interest. The program can automatically display whatever portions of the process are most critical at any time.

One of the nice aspects of performing a GDRS task on a micro is that the graphics do not generally have to be very fancy. A simple set of character graphics: horizontal, vertical, and diagonal lines, can usually provide all of the detail necessary.

The GDRS method can be used to solve many different types of problems. Think about its application in your areas of interest. It can be an effective and efficient method.

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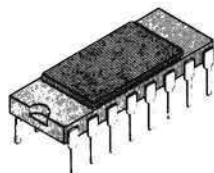
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SYM-1 Memory Search and Display

~~~~~  
**Add these two new commands to your SYM Monitor. They make it easy to locate any string in memory and provide a means to display data as ASCII when desired.**  
~~~~~

Nicholas Vrtis

Here are two more extensions for the SYM monitor. They are relocatable, and do not use any memory other than that normally used by the monitor. I decided to write these two software "tools" because I kept needing them and no one else seemed to be writing anything close to what I needed. The memory search routine was written because I needed some easy way to find locations in programs after I have relocated them. I don't have a printer, so after I have made a couple of patches and moves, it is sometimes difficult to find a particular place in the program. The command has also turned out to be helpful when you have to find references to a particular address so you can change it, as I had to do when I got the new monitor ROM.

The memory display routine was developed because I needed some easy way to look at messages, source lines, and other character type data in memory. This was especially true when I started working on a Tiny Basic Intermediate Language Assembler some time ago. The SYM monitor just doesn't have any way of displaying memory as characters instead of hex digits, and I have trouble recognizing ASCII as two hex digits.

The memory search routine will handle up to an eight byte search argument. This is normally entered in hex after the prompt from the routine. If you want, you can enter a slash instead of the two hex digits. This indicates a "wild" character to

the program. The definition of a "wild" character is that the position is counted, but any character is a valid match. This does not mean that you can't search for a slash character. The program will look for a slash if you enter it in hex as \$2F. This means that the search argument "20/OC" will find the first occurrence of any jump to a subroutine on page \$OC, but "202FOC" would only find a jump to the subroutine at \$C2F. This neat little programming trick is accomplished with a "byte used bit map" (how's that for a three dollar phrase?). In simple terms, each bit in SCPBUD corresponds to one byte in SCPBUF where the search key is saved. If the bit is on, it indicates that a "wild" character was entered in that position. A zero indicates a normal character. The distinction between a slash and \$2F is actually made by INBYTE. The slash is non-hex, so INBYTE returns with the carry set. If the overflow is set, then the second character was the non-hex and it is an error. If the equal is set the character was the carriage return, and the program uses that to mean the end of the search argument. Finally, if none of the above is true, then the character that was entered is compared to a slash (INBYTE conveniently leaves the character in 'A'). For the slash, the carry is rolled into the bit map, setting the bit to a one. For normal hex bytes entered, the carry is clear on return from INBYTE, so when the rotate is done, a zero is set into the bit. The only other check made on input is to watch for more than eight bytes being entered. The beeper is

beeped, and the character is ignored once eight have been accepted.

To perform the search, the program moves the bit map to a work area, since it will be destroyed in the process of the search. Each time we want to make a comparison between the key and memory, we first rotate one bit from the bit map work area into the carry. If the carry is set after the rotate, then the bit was on, and the program just pretends it got an equal compare. If the carry wasn't set, then the search byte is compared to memory for an equal. Simple, isn't it? Each time an unequal is found, the search address is incremented, and the search starts from position one of the key again.

Once the search argument is found, it is simple to output the address and then the data from memory (not from the search key, since it has the slashes in it).

There are a couple of not so obvious points to mention. The input search key, the key length, and the bit map are retained in the SYM RAM scope buffer area. This means some good news, and some bad news. The good news is that provided you don't do any output to the LED's, the argument will still be there the next time you use the routine. Since the U4 option with no parameters entered starts at the last used location plus one, using this option and entering a carriage return immediately for the search key will find the next occurrence of that string. The bad news is that the routine won't work if you

are using the hex keypad for entry. Actually, the three parameter option will work since it doesn't do any I/O until after it has hit the end of memory, or found the string. The problem is that any time you do output to the LED's, that character also gets rotated into the scope buffer area, so the process of entering the search key shifts it over. If you are using the hex keypad and want to use the search routine, you will have to supply a 10 byte work area someplace else.

Finally, the value of "end of memory" is set to \$0F at location \$211 for my 4K system. If you have more or less memory, set this to the highest page number in your system.

As I mentioned earlier, the memory display routine is primarily designed for displaying ASCII type information. It has also turned out to be somewhat useful as a normal memory display since it displays more bytes per line than does the Verify command. Another advantage is that it ends with the "OLD" address pointing to the next location after the last one displayed. This means that repeated calls to the command without any argument will continue displaying memory.

The display format is a typical dump format. Sixteen bytes of data are displayed, first in hex, and then as alpha. Before the alpha is output, though, it is checked to make sure that it is a displayable character. As written, this program translates control characters, lower case character, and anything with the high order bit on, to an underscore. On some terminals this will display as the back-arrow. The purpose is to occupy a position with displayable characters so you can count how many characters in you are from the start of the line. If your terminal will display lower case, you may want to change location \$30C to the highest displayable character for your terminal (lower case z is \$7A). I would not recommend by-passing the translation of the control characters. At best, most terminals don't even print a space in their place, and at worst, they do unexpected things which make reading the line difficult.

For those of you who have put up the other monitor extensions from my article in the August issue, these

routines can be added very easily. Simply change the address in the JMP U1 instruction that was at \$237 in the listing, to a JMP U4 where U4 is the address that the new routines are moved to. Then change this program at \$2AE to insert a JMP U1 in place of the SEC-RTS-NOP, and presto!—you have two new extensions. Both routines U4 and U5 are relocatable, so you don't have to bother running them through Relocate. Just block move them to where you want them. I moved them to the front of the Execute setups so I wouldn't have to learn a new starting address.

For those of you who didn't read the article, I will review some of the comments about how to extend the SYM monitor. First let me say that these routines are relocatable, with the only provision being that they must be in the same relative position to each other, or the branch at \$268 will have to be adjusted. If you decide to only use U4, change the above location to a SEC-RTS (\$3860). The U5 routine will operate by itself without any changes. As I mentioned before, these routines use only those memory locations normally reserved for the monitor, so they shouldn't conflict with your existing programs. Nor will they affect the operation of any of the SYM commands, with the exception that the 'OLD' address that is referred to in the manual will get changed by these commands in addition to the standard commands.

The SYM monitor vectors all "unrecognized" commands via a RAM vector located at \$A66D. The monitor considers anything it isn't programmed for as unrecognized. Normally, \$A66D points to an SEC-RTS sequence. This indicates to the routine ERMSG that the ER xx message should be printed. By the way, the xx is the hex digits for what is in 'A' when ERMSG is called, so this makes a handy error routine for your own programs. Since SYNERTEK was nice enough to put this vector in Ram, it can be changed. Specifically in our case if it is changed to point out the starting address of U4, the monitor will branch there instead of to the SEC-RTS. If you will note, these routines execute and SEC-TRS whenever they encounter an error, or the command is not the cash value for U4 or U5. For a normal return, they have to

make sure the carry is clear or the error message would get printed.

The monitor routines used in these programs are normal labels as defined in the cross reference listing for the monitor. In order to possibly save some of your sanity when you look at the code, I will mention that the parameter input areas are not numbered the way you would expect. The monitor always accepts input into the P3 area, and each time a new parameter is entered, it shifts the whole area up 16 bits. This means that if only one parameter is entered, it ends up in the P3 area, not in P1 as you would expect. For two parameters, the first parameter is in P2, and the second in P3. For three parameters, the numbers come out right. It gets sort of confusing the first time you try to figure it out, and those are not memory locations you can use any of the commands to look at, since the monitor zeros them out at the start of each command.

These routines were written for version 1.1 of the SYM monitor, which is a little different from version 1.0. In V1.0, both unrecognized commands and syntax errors (i.e. non-hex digits) were vectored through \$A66D, not just the unrecognized commands as in V1.1. This means that if you have V1.0 you have to check to make sure that you are not there because of a syntax error. In order to make these work for version 1.0, insert the following just before U4 and make it the address that goes into \$A66D:

```
CD 57 A6      CMP LSTCOM
See if command terminated properly
F0 02      BEQ U4      Branch if OK

38          SEC      Else set the error flag

60          RTS      and return to the monitor
```

This will take care of things for both U4 and U5. People who already have my other extensions up won't have to bother, since UO already check for this condition before it does anything else.

The sixteen bit checksum for \$200-\$31F is \$8F1B.

μ


```

LOC ----OBJECT----- STMT
00001 *****
00002 * SYM-1 USER MONITOR FUNCTION EXTENSIONS
00003 *
00004 * U4 - MEMORY SEARCH
00005 * 0 PARMS SEARCH FROM 'CURAD+1' TO 'END OF MEMORY'
00006 * 1 PARM SEARCH FROM PARM 1 TO 'END OF MEMORY'
00007 * 2 PARMS SEARCH FROM PARM 1 TO PARM 2
00008 * 3 PARMS SEARCH FOR PARM 1 AS ADDRESS FROM PARM 2 TO PARM 3
00009 * U5 - DISPLAY ALPHA MEMORY
00010 * 0 PARMS DISPLAY 1 LINE FROM 'CURAD'
00011 * 1 PARM DISPLAY 1 LINE FROM PARM 1
00012 * 2 PARMS DISPLAY FROM PARM 1 TO PARM 2
00013 *
00014 *****

LOC ----OBJECT----- STMT
00016 TEXT ***** OBJECT CODE OF SYM-1 MONITOR EXTENSIONS *****
00017 TEXT ***** INITIALIZATION MONITOR COMMANDS *****
00018 ORG $200

00020 *****
00021 * PAGE ZERO ADDRESS LOCATIONS
00022 *****
00023 *
00024 CURAD EQU $FE SYM-1 'OLD' ADDRESS
00025 ADJUSTMT EQU $FC SYM-1 SCRATCH PAGE ZERO AREA
00026 PZSCR EQU $FC SYM-1 SCRATCH PAGE ZERO AREA

LOC ----OBJECT----- STMT
02001 U4 - MEMORY SEARCH SYM-1 MONITOR EXTENSION
00028 TEXT ***** U4 MEMORY SEARCH SYS-1 EXTENSION *****
00029 *****
00030 * U4 MONITOR EXTENSION FOR THE SYM-1 -- MEMORY SEARCH
00031 *****
00032 *
00033 * BY: N. VRTIS - LSI/CCSD
00034 *
00035 * ACTION DEPENDS ON NUMBER OF PARMS ENTERED
00036 * 0 PARMS SEARCH FROM 'CURAD+1' TO 'END OF MEMORY'
00037 * 1 PARM SEARCH FROM PARM 1 TO 'END OF MEMORY'
00038 * 2 PARMS SEARCH FROM PARM 1 TO PARM 2
00039 * 3 PARMS SEARCH FOR PARM 1 AS ADDRESS FROM PARM 2 TO PARM 3
00040 *
00041 * NOTES:
00042 * 1) EXCEPT FOR THE 3 PARM OPTION, A SLASH ENTERED AS A SLASH
00043 * INSTEAD OF HEX 2F WILL BE CONSIDERED A 'WILD CHARACTER'
00044 * 2) IF NO SEARCH ARGUMENT IS ENTERED, THE VALUES FROM LAST TIME
00045 * WILL BE USED.
00046 * 3) THIS ROUTINE USES THE SYSTEM RAM SCOPE BUFFER FOR SCRATCH
00047 * AREA, SO IT WILL ONLY WORK WITH A TERMINAL UNLESS ANOTHER
00048 * SCRATCH AREA IS PROVIDED.
00049 *
00050 *****

0200 C9 18 00052 U4 CMP #18 CHECK FOR 'U4' COMMAND
0202 00 64 00053 RNE TOU5 TRY NEXT COMMAND IF NOT THIS ONE
00054 *
0204 E0 01 00055 CPX #1 SEE HOW MANY PARMS
0206 90 08 00056 BCC NOPRMS BRANCH IF ZERO PARMS
0208 00 17 00057 BNE TRYNXT OR IF MORE THAN 1
020A 20 A7 82 00058 JSR P3SCR MOVE STARTING ADDRESS TO 'CURAD'
020C 20 BE 82 00059 JSR DECCMP BACKUP 1 SO INC COMES OUT OK
020E A9 0F 82 00060 LDA #0F ZERO PARMS - USE HIGHEST RAM ADDR.
0210 80 48 A6 00061 STA P3H
0212 80 48 A6 00062 DEC P3L
0214 FE 4A A6 00063 JSR INCCMP MAKE LOW ORDER = $FF
0216 20 20 82 00064 BEQ GETARG BUMP CURAD BY ONE
0218 F0 20 82 00065 GETARG GETARG
021A F0 20 82 00066 GETARG GETARG
021C 90 1E 00067 BCC DONE IF ALREADY TO END OF MEMORY
021E 18 1E 00068 CLC RETURN TO MONITOR
0220 60 1E 00069 RTS PRESERVE # OF PARMS ENTERED
0222 8A 9C 82 00070 JSR P2SCR P2 AREA HAS 'FROM' FOR 2 & 3 PARMS
0224 C9 02 82 00071 CMP #2 CHECK WHICH
0226 F0 14 82 00072 BEQ GETARG GET ARGUMENT IF 2 PARMS
00073 *
0228 AD 4E A6 00073 LDA P1L ELSE MOVE PARM1 TO SEARCH KEY
022C 80 02 A6 00074 STA SCPBUF
022E AD 4F A6 00075 LDA P1H
0230 80 01 A6 00076 STA SCPBUF+1
0232 A9 00 00077 LDA #00
0234 85 FC 00078 STA PZSCR INDICATE BYTES USED
0236 A2 02 00079 LDX #2 MAKE X=2 AS LENGTH

LOC ----OBJECT----- STMT
0238 D0 2D 00080 BNE GOTCR AND WE HAVE THE PARM IN NOW
00081 *
023D A2 02 00082 GETARG LDX #0 NUMBER OF BYTES ENTERED
023F 86 FC 00083 STX PZSCR SET TO ALL BYTES USED
0241 20 4D 83 00084 JSR CRLF START ON A NEW LINE
0243 A9 3F 83 00085 LDA #1> DISPLAY PROMPT
0245 20 47 8A 00086 JSR OUTCHR
0247 20 09 81 00087 JSR INBYTE GET SEARCH INPUT
0249 80 7C 81 00088 RCS NEED TO CHECK FOR / IF NON-HEX
024B F0 08 81 00089 CPX #8 SEE IF GOT ENOUGH ALREADY
024D 80 10 81 00090 RCS CAN'T HANDLE ANY MORE
024F 80 08 81 00091 STA SCPBUF,X ELSE SAVE THE BYTE
0251 90 00 81 00092 ROL PZSCR ROLL CARRY INTO BYTES USED
0253 26 FC 81 00093 ROL PZSCR BUMP FOR NEXT ONE
0255 E8 81 00094 RNE GALOOP UNCONDITIONAL
0257 D0 EF 81 00095 BVS GALOOP IF SECOND IS NON-HEX IT IS BAD
0259 70 06 81 00096 GOTCR BRANCH IF IT WAS CARRIAGE RETURN
025B F0 0C 81 00097 CMP #1/ ELSE CHECK FOR A SLASH
025D C9 2F 81 00098 REQ ROLLIN IF YES - CARRY IS SET FOR ROLLIN
025F F0 F3 81 00099

```

0262	20	72	99	00099	BADY	JSR	BEEP	ERROR CHARACTER BEEP THE BEEPER
0265	18			00100	CLC			CLEAR CARRY
0266	90	E1		00101	BCC	GALOOP		TO FORCE BRANCH
				00102	*			
0268	00	40		00103	TOU5	BNE	U5	JUST PASSING THROUGH ON WAY TO U5
				00104	*			
026A	CA	08		00105	GOTCR	DEX		SEE IF GOT ANY SEARCH CHARACTERS
026B	30	1F	A6	00106	BMI	EACHST		BRANCH IF NOT
026D	8F	1F		00107	STX	SCPSTL		ELSE SAVE STRING LENGTH
0270	A5	FC		00108	LDA	PZSCR		MOVE BYTES USED TO HOLD AREA
0272	8D	1F	A6	00109	STA	SCPBUO		
				00110	*			
0275	AC	1F	A6	00111	EACHST	LDY	SCPSTL	START OF TAIL END OF STRING
0278	AD	1F	A6	00112	LDA	SCPBUO		MOVE BYTES USED MAP TO WORK AREA
				00113	STA	PZSCR		
027D	6A	FC		00114	EACHCH	ROR	PZSCR	ROLL 1 BIT OF MAP INTO CARRY
027E	80	07		00115	BCC	ISMTCH		IF ON IT WAS A SLASH AND IS MATCHED
0281	R1	FF		00116	LDA	(CURAD),Y		OTHERWISE
0283	09	00	A6	00117	CMP	SCPBUO,Y		COMPARE SEARCH KEY TO THIS BYTE
0286	00	19		00118	RNF	NOMTCH		BRANCH IF NOT A MATCH
0288	88			00119	ISMTCH	DEY		GOT A MATCH - NEXT SEARCH CHAR
0289	10	F2		00120	RPL	EACHCH		CONTINUE IF MORE IN STRING
				00121	*			
028B	20	16	93	00122	JSR	CRLF5Z		ELSE OUTPUT ADDRESS OF START
028E	20	42	R3	00123	JSR	SPACE		
0291	C8			00124	INY			PUT Y BACK TO ZERO
0292	B1	FE		00125	OUTLOP	LDA	(CURAD),Y	LIST THE CHARACTERS FOUND
0294	20	FA	B2	00126	JSR	OUTBYT		
0297	C8			00127	INY			
0298	CC	1F	A6	00128	CPY	SCPSTL		
029B	90	F5		00129	BCC	OUTLOP		
029D	F0	F3		00130	BEQ	OUTLOP		DON'T FORGET THE LAST BYTE
029F	18			00131	CLC			CLEAR CARRY
02A0	60			00132	RTS			AND RETURN TO MONITOR
				00133	*			
02A1	20	B2	B2	00134	NOMTCH	JSR	INCCMP	NO MATCH -BUMP TO NEXT START ADDRESS
02A4	90	CF		00135	EACHST	BCC	EACHST	CONTINUE SEARCH IF MEMORY LEFT
02A6	F0	C0		00136	BEQ	EACHST		
02A8	18			00137	CLC			ELSE RETURN TO MONITOR
02A9	60			00138	RTS			
02AA				00140	TEXT			
				00141	*****	U5 - DISPLAY MEMORY SYM-1 EXTENSION	*****	
				00142	* U5 MONITOR	EXTENSION FOR THE SYM-1 -- DISPLAY ALPHA MEMORY	*	
				00143	*****		*****	
				00144	*		*	
				00145	* BY: N. VRTIS - LSI/CCSD		*	
				00146	*		*	
				00147	* ACTION:	SIMULAR TO SYM 'VERIFY', EXCEPT 'OLD' POINTS TO NEXT	*	
				00148	*	ADDRESS AFTER THE COMMAND.	*	
				00149	* 0 PARMS	DISPLAY 1 LINE FROM 'CURAD'	*	
				00150	* 1 PARM	DISPLAY 1 LINE FROM PARM 1	*	
				00151	* 2 PARMS	DISPLAY FROM PARM 1 TO PARM 2	*	
				00152	*		*	
				00153	*****		*****	
				00155	U5	CMP	#\$19	CHECK FOR U5 HASH CODE
02AA	C9	19		00156	REQ		U5STR	BRANCH IF YES
02AC	F0	03		00157	*			
				00158	USERR	SEC		RAISE THE ERROR FLAG
02AF	60			00159	RTS			AND RETURN TO MONITOR
02B0	EA			00160	NOP			SO ABOVE CAN BECOME A JMP
				00161	*			
02B1	F0	02		00162	U5STR	CPX	#2	CHECK FOR 2 PARMS
02B3	F0	22		00163	REQ	PRMS2		BRANCH IF YES
02B5	80	F7		00164	RCS	USERR		MORE IS TOO MANY PARMS
02B7	F0	01		00165	CPX	#1		HOW ABOUT 1 PARM
02B9	F0	0A		00166	REQ	PRMS1		BRANCH IF YEP
				00167	*			
02B8	A5	FE		00168	LDA	CURAD		GEE - MUST BE 0 PARMS
02B9	8D	4A	A6	00169	STA	P3L		MOVE CURRENT ADDRESS TO P3
02C0	A5	FF		00170	LDA	CURAD+1		
02C2	8D	48	A6	00171	STA	P3H		AND FALL THROUGH AS IF 1 PARM
02C5	20	A7	B2	00172	PRMS1	JSR	P3SCR	MOVE STARTING ADDRESS TO P.2.
02C8	18			00173	CLC			COMPUTE 1 BYTE PAST ENDING ADDRESS
02C9	A5	FE		00174	LDA	CURAD		
02CA	69	10		00175	ADC	#16		***** BYTES PER LINE HERE *****
02CD	8D	4A	A6	00176	STA	P3L		
02D0	90	08		00177	BCC	DOOUT		DONE IF NO CARRY
02D2	EF	48	A6	00178	INC	P3H		ELSE TAKE CARE OF CARRY
02D5	00	06		00179	BNE	DOOUT		AND THEN DONE
02D7	20	9C	B2	00180	PRMS2	JSR	P2SCR	2 PARMS HAS STARTING IN P2 - END=P3
02DA	20	93	B2	00181	JSR	INCP3		BUMP END BY 1 FOR COMPARE
				00182	*			
02D9	20	16	93	00183	DOOUT	JSR	CRLF5Z	START ON A FRESH LINE
02E0	A2	10		00184	LDA	#16		***** BYTES PER LINE HERE *****
02E2	A5	FE		00185	LDA	CURAD		SAVE STARTING ADDRESS
02E4	48			00186	PHA			
02E5	A5	FF		00187	LDA	CURAD+1		WILL NEED IT LATER
02E7	48			00188	PHA			
				00189	*			
02E8	20	42	B3	00190	ANOTHR	JSR	SPACE	SPACE BETWEEN CHARS
02EB	A0	00		00191	LDY	#0		MAKE SURE REGISTER IS ZERO
02ED	B1	FE		00192	LDA	(CURAD),Y		GET A BYTE OF DATA
02FF	20	FA	B2	00193	JSR	OUTBYT		THIS TIME IT IS OUTPUT AS HEX
02F2	20	B2	B2	00194	JSR	INCCMP		BUMP TO NEXT BYTE
02F5	80	03		00195	BCC	LASTPT		DO ASCII PART IF TO END
02F7	CA			00196	DEX			ELSE COUNT BYTES THIS LINE
02F8	D0	EF		00197	BNE	ANOTHR		DO ANOTHER IF ROOM LEFT
				00198	*			
02FA	20	3F	B3	00199	LASTPT	JSR	SPC2	2 SPACES BEFORE ASCII STARTS
02FD	68			00200	PLA			RESET CURAD BACK TO START
02FE	85	FF		00201	STA	CURAD+1		
0300	68			00202	PLA			
0301	85	FF		00203	STA	CURAD		
0303	A2	10		00204	LDA	#16		***** BYTES PER LINE HERE *****
0305	B1	FE		00205	(CURAD),Y			GET CHARACTER TO GO AS ASCII
0307	C9	20		00206	CMP	#\$20		MAKE SURE NOT CONTROL
0309	90	04		00207	BCC	MAKSPC		MAKE IT SPECIAL IF SO
030B	C0	58		00208	CMP	#\$58		AS SHOULD DO FOR LOWER CASE
030D	90	02		00209	BCC	OKDO		BRANCH IF NOT SPECIAL
030F	A9	5F		00210	MAKSPC	LDA	#\$5F	INSERT FILLER CHARACTER
0311	20	47	9A	00211	OKDO	JSR	OUTCHR	OUTPUT THE ASCII


```

0314 20 B2 82 00212 JSR INCCMP BUMP TO NEXT BYTE
0317 R0 05 00213 RCS U$DONE DONE IF NOW TO THE END
0319 CA 05 00214 REX U$DONE ELSE NEXT BYTE
031A D0 E9 00215 RNE ASCOUT SAME LINE IF NOT TO END
031C F0 BF 00216 REQ DDOUT ELSE START A NEW LINE

031F 18 00217 *
031F 60 00218 U$DONE CLC CLEAR ERROR FLAG
031F 00219 RTS AND RETURN TO MONITOR
00220 PGMEND EQU *-1 END OF PROGRAM ADDRESS MARKER

LOC ----OBJECT---- STMT SYM SYSTEM ADDRESS AND ROUTINES

00222 *****
00223 * SYM SYSTME ROUTINE ENTRY POINTS AND RAM ADDRESSES *
00224 *****

8109 00226 INBYTE EQU $8109 INPUT 2 HEX DIGITS INTO 'A'
8293 00227 INCP3 EQU $8293 INCREMENT P3 BY 1
829C 00228 P2SCR EQU $829C PUT PARM2 INTO 'CURAD'
82A7 00229 P3SCR EQU $82A7 PUT PARM3 INTO 'CURAD'
82B2 00230 INCCMP EQU $82B2 BUMP 'CURAD' & COMPARE TO PARM3
82BE 00231 DECCMP EQU $82BE SUBTRACT 1 FROM 'CURAD'
82FA 00232 OUTBYT EQU $82FA PRINT A (2 HEX DIGITS)
8316 00233 CR/LFSZ EQU $8316 OUTPUT CR/LF AND 'CURAD'
833F 00234 SPC2 EQU $833F OUTPUT 2 SPACES
8342 00235 SPACE EQU $8342 OUTPUT 1 SPACE
8347 00236 CR/LF EQU $8347 OUTPUT CR/LF
8972 00237 BEEP EQU $8972 TOOT THE ONBOARD BEEPER
8A47 00238 OUTCHR EQU $8A47 OUTPUT ASCII FROM 'A'
00239 *****
A600 00240 SCPUF EQU $A600 SCOPE OUTPUT BUFFER AREA
A61F 00241 SCPUF EQU $A61F BYTES USED BIT MAP
A61F 00242 SCPUF EQU $A61F SEARCH STRING LENGTH
A64A 00243 P3L EQU $A64A INPUT PARAMETER VALUES
A64B 00244 P3H EQU $A64B
A64C 00245 P2L EQU $A64C
A64D 00246 P2H EQU $A64D
A64E 00247 P1L EQU $A64E
A64F 00248 P1H EQU $A64F

END OF PASS 2-ERRORS= 00000 *****

```

Microcomputing is Nick Vrtis' hobby. He is employed by Lear Siegler, Inc. as a Senior System Software Specialist. For this, he works mainly on operating systems on the company's IBM computers, but he also delves into CICS and communication somewhat.

His system at home is a SYM-1. It has 5K RAM, soon to

be expanded to 8K. He also has Synertek BASIC and has played with Tom Pitman's Tiny Basic, which he has disassembled and modified. His current terminal is an old Datapoint 3300, and he also has a Radio Shack Quick Printer II hooked up through the TTY pot on the SYM. The assemblies that he gets are done with a cross assembler that he wrote to run on the IBM gear.

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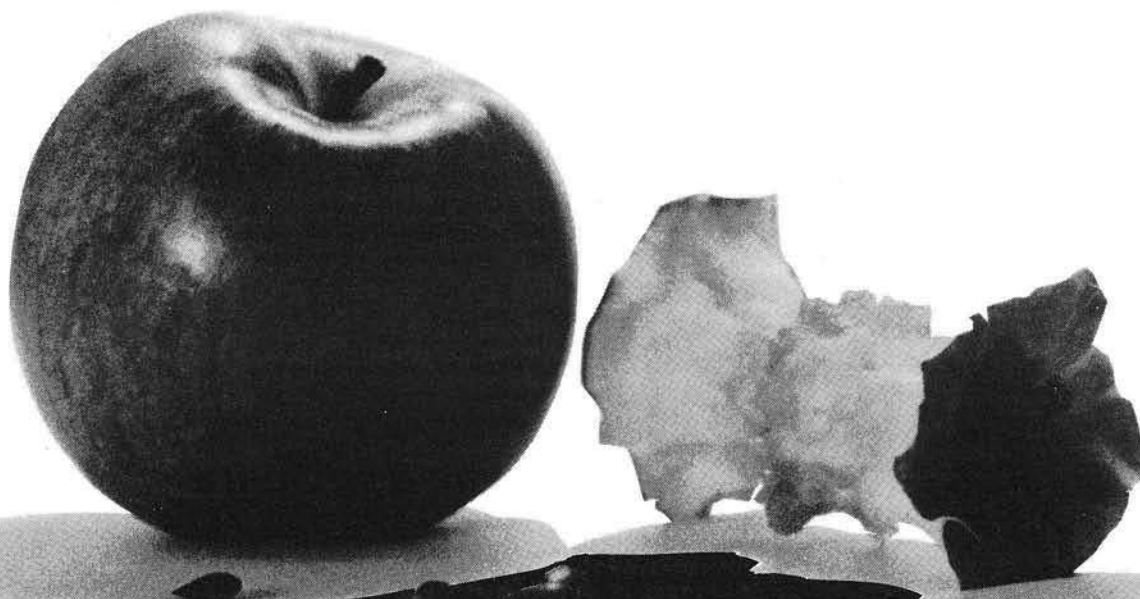
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Sorting Revealed

A truly fresh approach to understanding the basics of sorting. In addition to a particularly lucid discussion of various sorting methods, programs are presented which demonstrate the sorting algorithms in action.

Richard C. Vile, Jr.

It has often been said that a picture is worth a thousand words. Sadly, this maxim is frequently ignored by professional educators, especially when dealing with such bone-dry subjects as mathematics and computer science. This article will present a detailed example of the use of a simple, yet effective, visual technique for giving insight into the basis for certain algorithms. Our approach will be to show the algorithm in action. Our medium will be the Apple II personal computer, but any computer which provides a memory-mapped display will do. The vehicle for the demonstration will be one of the staples of the computer science curriculum — the joy of pedants and the bane of poor benighted students — viz. sorting algorithms.

Sorting Theory

Unfortunately, we must stoop to pedantry to begin with. The reader who is already well-versed in sorting lore may skip directly to Sorting Implemented.

Sorting is such a varied and vast topic that large portions of entire books have been devoted to it. Perhaps the best known compendium of sorting facts and theory is to be found in Knuth's robust volume *Sorting and Searching* (The Art of Computer Programming Vol. 111, Addison Wesley, 1973). Our demonstration will be limited to just a few of the better known sorting algorithms, although the techniques could be applied to others as well. We shall provide programs that allow the visualization of five dif-

ferent sorting algorithms: bubble sort, Shell sort, insertion sort, selection sort, and quicksort. Of these, we shall discuss the bubble sort and quicksort in some detail prior to the presentation of the programs. Details of the others may be found in almost any good introductory computer science text, as well as in most texts on data structures.

Apart from the specific details of the algorithms used, the theory connected with sorting deals with efficiency. When people who are "in the know" discuss sorting, they will frequently bandy about certain terminology which they don't bother to explain. In hopes of increasing the number of cognoscenti involved in such discussions, we shall now attempt to lay out some of the more common terms for you.

To simplify matters somewhat, let us assume that all of our sorting will take place entirely in memory. Sorting methods that involve storing intermediate stages on disk files or magnetic tape, so-called external sorts, will be beyond our scope, although presumably not beyond our ken. The objects to be sorted will be assumed to be numbers, either integer or floating point, stored in memory in an array of one dimension and of a given size. The size of the array being sorted will be a hit personality throughout the discussion, so we give it a name. It will be denoted by N .

Number of elements to sort = N

In order to fully comprehend one

of the definitions to be given later, it is necessary to indulge in a bit of mathematics. We shall need to understand two functions. In particular:

$\text{Log}_2 x$ = base 2 logarithm of x
 $\lfloor x \rfloor$ = floor of x

Actually, we are interested in the combination of these functions as applied to the friendly value N :

$\lfloor \log_2 N \rfloor$

i.e. the floor of the base 2 logarithm of N . Before you run screaming to the nearest math anxiety clinic, at least read the next few sentences of explanation.

Suppose you have a pile of N coconuts (why coconuts, you ask? Why not, we reply!). Think about the following process:

1. Subdivide the pile into two piles which are as nearly equal in size as possible.
2. Take the smaller of the two piles from step 1. If it consists of one coconut, then stop. Otherwise, repeat from step 1.

Now how many times did you do step 1? The answer is the value of $\lfloor \log_2 N \rfloor$! So, without worrying about picky details, the floor of the base 2 logarithm of N is the number of times you can divide N by 2 and still retain a non-zero quotient. Figure 1. pictures a simple case.

An alternate way of thinking about

the situation involves collecting coconuts. The procedure is as follows:

1. Begin with a single coconut.
2. If doubling the number, k , of coconuts which you already have would cause your total to exceed N coconuts ($2k$ is greater than or equal to N), then stop.
3. Collect k more coconuts, giving you $2k$, and repeat step 2 now thinking of the new total as the value of k .

Now how many times did you execute step 3? The answer will again be $\lfloor \log_2 N \rfloor$. Before you go on, try to convince yourself (without flying to Tahiti to collect real coconuts), the two procedures yield the same result.

We shall return to this value, the "coconut number", later.

In order to talk about the efficiency of any algorithm, we need some quantities that we can measure. For sorting algorithms, we concentrate on two: the number of comparisons and the number of interchanges.

A comparison occurs whenever a member of the collection of numbers is compared to something else. The something else could be a value fished out of a hat, or it could be another member of the collection. Thus, a statement such as IF $A(I) > A(I+1)$ THEN...counts as a comparison, as well as IF $A(I) > \text{MAX}$ THEN...

An interchange occurs whenever a member of the collection of numbers is moved from one place to another in the computer's memory, and possibly some other number takes its place. The classic interchange may be described by the sequence of three statements:

```
TEMP = A(I)
A(I) = A(J)
A(J) = TEMP
```

(assuming, ofcourse, that $I \neq J$). Not all sorting algorithms use this classic form, but there is usually an easily identified interchange step whose repetition we can count.

Trying to count the number of comparisons and/or interchanges which take place during the course of execution of a sorting algorithm

will give an approach to measuring the efficiency of that algorithm. In addition to comparisons and interchanges, there will also be overhead involved in a sorting algorithm: i.e. the computing time used in loop control, recursion, etc. This is more difficult to measure theoretically and is therefore usually deduced from empirical observations.

Being armed with a few terminological weapons, we may now attack some of the more familiar sorting buzz phrases. Assume we are speaking of the number of comparisons made during the execution of some sorting algorithm. Then we may speak of an N^2 sorting algorithm (pronounced N-squared). This means that "on the order of" N times N comparisons will be made in the course of sorting an array of size N . Well, that was relatively painless — at least as a definition! The interesting (painful) part comes when we try to prove that a given algorithm is an N^2 algorithm. We shall get to that in the next section.

Another phrase which is frequently encountered when casually "talking sorts" is: that's an $N \log N$ sort (pronounced N log N!). What that actually means is that the expected number of comparisons in carrying out the sorting algorithm for an array of size N is:

$$N * (\log_2 N)$$

That is, N multiplied by the coconut number. Again, this is easy enough to say, but perhaps a bit harder to

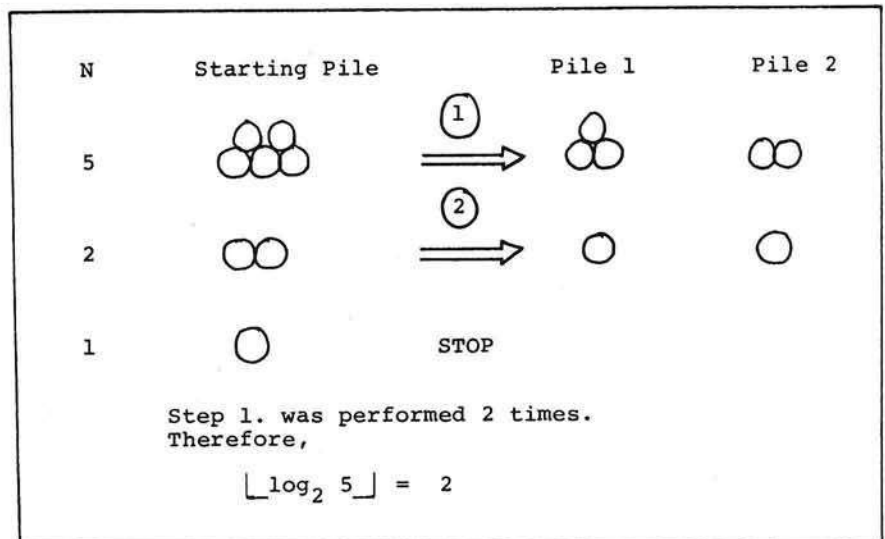


Figure 1

appreciate than the N^2 description. After all, why should we be concerned with these numbers, and what is the significance of the difference between them?

Consider briefly, Table 1. It shows values for N , N^2 , $\lfloor \log_2 N \rfloor$, and $N * \lfloor \log_2 N \rfloor$. Assuming that overhead is relatively constant, or at least negligible from one algorithm to the next, we see that there is an ever-increasing difference between N^2 and $N \log N$ (from now on, we assume that $\log N$ means $\lfloor \log_2 N \rfloor$). To make the comparison more concrete, let us assume that a comparison costs .001¢, and that we need to sort an array containing 1,048,576 numbers. Using an N^2 sort will cost \$10,995,116.27, whereas using an $N \log N$ sort will only put us out \$209.72 Of course, a single comparison of two numbers on today's monster computers-or "big iron" as they are sometimes referred to in the trade- costs considerably less than .001¢. But even at .0000001¢ per comparison - a rate of 10,000,000 comparisons per penny- the cost differential will be 2¢ for the $N \log N$ sort-\$1,099.51 for the N^2 sort! With that kind of comparison, you can see why no commercially viable sorting package is going to use the N^2 sorting approach.

Some Sorting Algorithms

We now present two of the more well known sorting algorithms in some detail. We will attempt informally to prove that the first is an N^2

algorithm. The second algorithm discussed is an example of an $N \log N$ algorithm, but we shall spare the reader any attempts at proof.

Bubble Sort

This algorithm is probably the most widely known and loathed by students of introductory computer science. Many an instructor has droned on about its properties to unwilling students of FORTRAN! For many of these students, it is their only taste of the vast menu of sorting techniques.

We assume that N elements, which we shall denote by $A(1)$, $A(2)$, ..., $A(N)$, are to be arranged in ascending order; in short, sorted. The bubble sort operates by making repeated "sweeps" through the array, causing various elements to "bubble — up" in the process. We shall see that for each sweep, at least one element is guaranteed to be positioned in its correct final slot in the array.

The heart of each sweep is the idea of comparing two adjacent entries in the array:

$A(I) \quad A(I+1)$

If $A(I)$ has a greater value than $A(I+1)$, then the two elements are known to be out of correct order and need to be swapped. This is accomplished by the use of the classic interchange, which we illustrate here in BASIC and Pascal:

N	N^2	$\log N$	$N \log N$
64	4096	6	384
128	16,384	7	896
256	65,536	8	2,048
512	262,144	9	4,608
1,024	1,048,576	10	10,240
2,048	4,194,304	11	22,528
4,096	16,777,216	12	49,152
8,192	67,108,864	13	106,496
16,384	268,435,456	14	229,376
32,768	1,073,741,824	15	491,520
65,536	4,294,967,296	16	1,048,576
131,072	17,179,869,184	17	2,228,224
262,144	68,719,476,736	18	4,718,592
524,288	274,877,906,944	19	9,961,472
1,048,576	1,099,511,626,776	20	20,971,520

Table 1

Now consider the iterations of this fundamental step which are necessary in order to bring the entire array into sorted order. First, suppose we are just beginning. Then we can make no assumptions about the sizes of the array elements, relative to their positions in the array. Thus, suppose we iterate the fundamental compare-maybe-swap step over values of I ranging from 1 to $N-1$ (why not 1 to N ?). That is, we will successively compare $A(1)$ and $A(2)$, $A(2)$ and $A(3)$, and so on, until we reach $A(N-1)$ and $A(N)$. Positions of various elements will change through swapping. In particular, the largest numerical value in the original array is guaranteed to wind up in $A(N)$. Positions of various elements will change through swapping. In particular, the largest numerical value in the original array is guaranteed to

wind up in $A(N)$ after the sweep is completed. To convince yourself that this is true, ask, "If the largest value is originally in $A(J)$, then what other array entries will it be swapped with?"

The last paragraph has indicated that we can reach a picture such as that shown in Figure 3, after one sweep of the array. What has been accomplished? We have partially sorted the original array. How much of the resulting array is now in correct order? One element — the last. Note that this is the same as the number of sweeps we have made. Now suppose we make a second sweep through the array, comparing $A(1)$ and $A(2)$, $A(2)$ and $A(3)$, etc. until we reach $A(N-2)$ and $A(N-1)$. It is not necessary to compare $A(N-1)$ and $A(N)$, since we know that $A(N)$ is already in its correct final position. Moreover, $A(N-1)$ is now also guaranteed to be the second largest element in the array, and therefore in its correct final position. Thus the original array has been divided into two pieces: the elements $A(1)$, $A(2)$, ..., $A(N-2)$, still possibly unsorted, and the elements $A(N-1)$ and $A(N)$, both where they 'should be'. We have made two passes and put two elements in their correct positions.

Continuing this process by making passes through less and less of the array will cause more and more of the 'tail end' of the array to be in correct final order and leave less and less of the beginning of the array to still be sorted. Altogether it will take $N-1$ passes through the array to guarantee that it is totally sorted. The reason that it does not require N passes is that the last pass causes two elements to wind

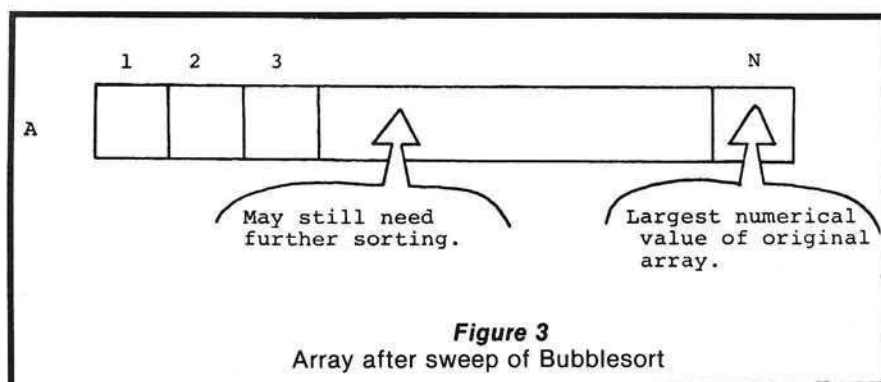
BASIC

```
100 IF A(I) <= A(I+1) THEN 140
110 TEMP = A(I)
120 A(I) = A(I+1)
130 A(I+1) = TEMP
140 ...
```

Pascal

```
if A[I] > A[I+1] then
begin
    Temp := A[I];
    A[I] := A[I+1];
    A[I+1] := Temp;
end;
```

Figure 2
The "Classic Interchange"



up in their correct places, instead of just one. Figure 4 gives both a BASIC and a Pascal version of the complete bubble sort algorithm.

Now let us see if we can count the number of comparisons that will be made. Each sweep through the array corresponds to one pass through the inner loop of the algorithm. The number of comparisons made will be the same as the value of the upper limit of this loop, which according to Figure 4, is $N-1$. The value of l is varied by the outer loop and runs from 1 to $N-1$. Thus, there will be:

$N-1$ comparisons the first time through the loop.
 $N-2$ comparisons the second time through the loop.
 $N-3$ comparisons the third time through the loop.

... ..
 $N-(N-2)=2$ comparisons the $(N-2)$ nd time through the loop
 $N-(N-1)=1$ comparisons the $(N-1)$ st time through the loop.

The total number is therefore:

$(N-1) + (N-2) + \dots + 3 + 2 + 1$
 This number is known in

mathematics as a 'triangular' number, and by a formula from algebra may be expressed solely in terms of N as $1/2 (N^2 - N)$. Consequently, there are about N^2 comparisons made.

The inefficiency of the bubble sort is compensated for by its simplicity, especially from a pedagogical point of view. It is totally trivial to program, as we have seen. Consequently, it is quite acceptable for sorting tasks that only involve 'small' values of N .

Quicksort

Quicksort, invented by C.A.R. Hoare, is probably the most 'elegant' of the sorting techniques yet devised. It is an $N \log N$ sort, which is based on a very simple idea and in its most compact form may be programmed in very few lines of code. In fact, probably the greatest difficulty in grasping how it works involves understanding the administrative details of how to apply the basic step which motivates its

operation. One has the tendency to say, 'You mean, that's all there is to it?', or 'But what do you mean by simply apply the same procedure to both halves?'. Nonetheless, once appreciated, it is an algorithm you will never forget. That should be reward enough for the effort expended in understanding it in the first place.

The basic idea underlying Quicksort is to perform interchanges of non-adjacent array elements in hopes of bringing order to the array more quickly (bubble sort has already demonstrated the inefficiency of interchanging adjacent entries). The idea is applied using the concept of a *partition* of the array elements.

To partition the elements $A(P)$, $A(P+1)$, ..., $A(Q)$ of the array A , where $P \geq 1, P \leq Q, Q \leq N$, requires that some value X which actually occurs as one of the entries $A(P)$, $A(P+1)$, ..., $A(Q)$ be placed into its correct final position, say K , and that the remaining elements are arranged so that $A(l) \leq A(K)$ for $O < K$ and $A(J) \geq A(K)$ for $J > K$. The results are pictured in Figure 5.

For convenience in implementation (although this may not be the optimal choice in theory), we shall always choose $A(P)$ as the value X , which is to be inserted into its correct final resting place. To accomplish our end result, we adopt the following 'double-barreled' scan:

Start with $l = P+1$ and $J = Q$. Scan forward from l (i.e. in increasing l -value order) until we find $A(l)$ for which $A(l) \geq X$. Scan backward from J (i.e. in decreasing J -value order) until we find $A(J)$ for which $A(J) \leq X$. Then interchange $A(l)$ and $A(J)$, since they are both in the 'wrong half' of the partition according to the above definition. Continue this procedure until $J \leq l$. As a final act, interchange $A(P)$ and $A(l)$, where l now has its 'final' value. This puts $X = A(P)$ into its correct final position in the array. You should convince yourself that it also achieves the picture shown in Figure 5. Actually, there is one case which fails. See if you can discern what it is — we'll come back to it later on.

An example may make things a bit clearer. Figure 6 shows an un-

```

                                BASIC
10   FOR I = 1 TO N-1
20   FOR J = 1 TO N-I
30   IF A(J) <= A(J+1) THEN 70
40   TEMP = A(J)
50   A(J) = A(J+1)
60   A(J+1) = TEMP
70   NEXT J
80   NEXT I

                                Pascal
for I := 1 to N-1 do
  for J := 1 to N-I do
    if A[J] > A[J+1] then
      begin
        Temp := A[J];
        A[J] := A[J+1];
        A[J+1] := Temp;
      end;

```

Figure 4
Bubble sort algorithm in both BASIC and Pascal

sorted array of 16 elements, which is to be partitioned for $P=1$, $Q=16$. Shown are the first values of I and J for which an interchange of the partitioning process will take place. See if you can draw the final picture: showing the array with the partition complete and the value of K . The answer is shown in Figure 7.

When one gets down to programming the partitioning process, several details that may not have been previously obvious suddenly force themselves into the spotlight. In order to highlight these, we present in Figure 8 a Pascal procedure for the partition step. The first item which may catch your eye is that array A is indicated in the parameter list to be of size $N+1$, instead of N . The reason may be seen by studying the second repeat statement of Figure 8:

```

repeat
  I := I + 1
until A(I) ≥ Value;

```

As with all loops, the programmer should be sure that there is a way out! In this case, if the elements $A(1)$, $A(2)$, ..., $A(N)$ of the array are assumed to be randomly distributed

among all possible values, then there is no guarantee that any of them satisfies the condition $A(I) \geq \text{Value}$. Thus, we have extended the array and stored a value in $A(N+1)$ which is guaranteed to be greater than or equal to any other value that could occur in the original array. In Pascal, the predefined identifier Maxint serves the purpose, and we may assume that the assignment $A[N+1] := \text{Maxint}$; has occurred in the calling routine. Now, even if all elements of A are strictly less than $A(1)$, the repeat loop will terminate

when it bumps into the Maxint value stored in $A[N+1]$. Such a value, which is not part of the data being manipulated, but instead serves to protect against some dire circumstances, is known as a *sentinel*.

This approach raises two further questions: first, do we face a similar problem with J ; and second, do we face the possibility of erroneously swapping $A(N+1)$ with some element of A . The first question is easily answered by realizing that $\text{Value} := A[\text{Lower}]$. Thus, if J is decreased so far that $J := \text{Lower}$, then $A[J] \leq \text{Value}$ is automatically true. Thus, the first repeat loop is guaranteed to stop because of this choice. To answer the second question, let's look closely at what happens when $N = \text{Upper}$ and $A(I) < \text{Value}$ for all I , $I = 2, 3, \dots, N$. The repeat statement:

```

repeat
  J := J - 1
until A[J] ≤ Value

```

immediately succeeds. J starts at $N+1$, $J-1 = N$ and $A(N) < \text{Value}$ by our assumption. Thus, J stops at the value N after the first time through the loop. On the other hand, the repeat statement for I will continue to fail, again by our assumption, until $I = N+1$. Now $I = N+1$ and $J = N$. This means that the test $I < J$ will fail. Therefore, the interchange shown inside the while loop will be skipped. Aha!, you say — caught you — nothing happens and Quicksort is a sham!! Fortunately, that is not true. The last two statements in the procedure:

```

A[Lower] := A[J];
A[J] := Value;

```

will be carried out, causing $A[\text{Lower}]$ and $A[N]$ to be swapped.

To assimilate the code of the pro-

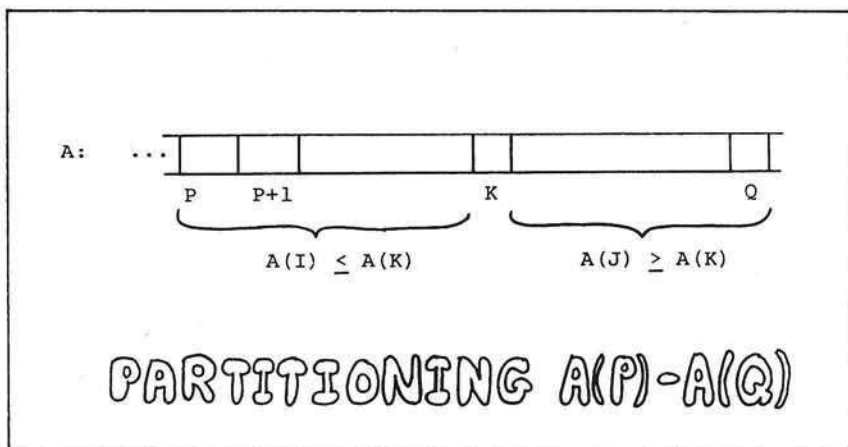


Figure 5

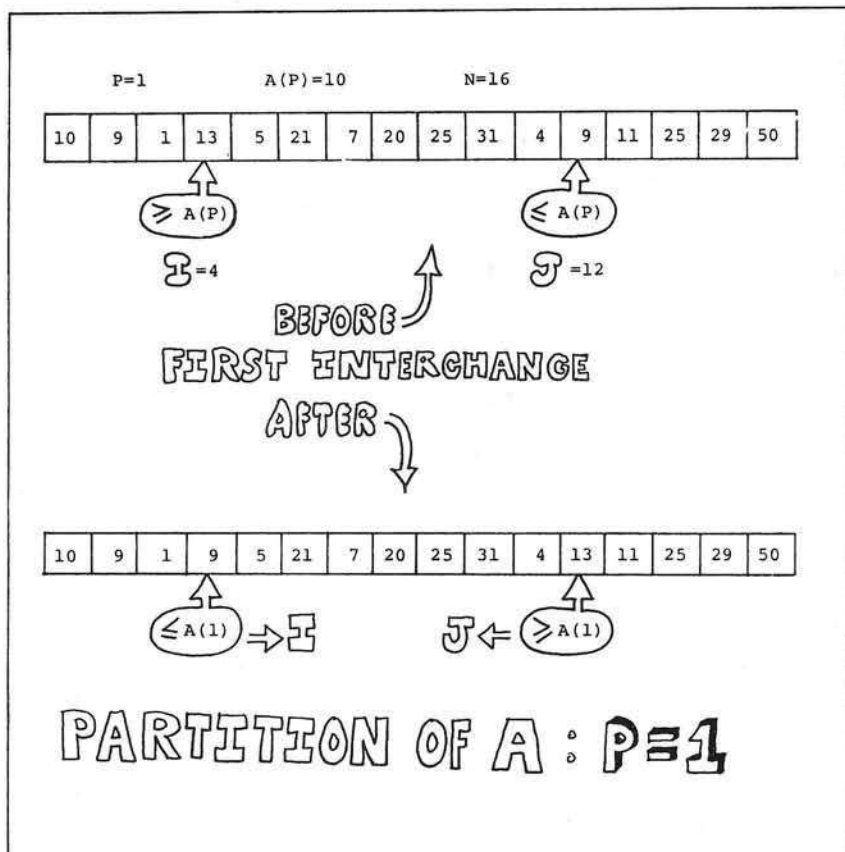


Figure 6

ACTION, STRATEGY, AND FANTASY for the **SERIOUS** games player and his **APPLE II**

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cedure, simulate its action on the array of Figure 6. As a final note, the procedure protects itself from funny initial values for Lower and Upper, by first checking to make sure that $\text{Lower} < \text{Upper}$. This will turn out to be necessary in one version (the recursive one) of the complete Quicksort algorithm, but must be moved back to the caller for the other version (the 'straight' or iterative one).

Now that we have studied the innards of the Quicksort algorithm, it is time to investigate how the partition step fits into the larger scheme of things. Once the original array A has been partitioned, we are left with one element in its correct final resting place and two subarrays that remain to be sorted. The beauty of Quicksort is that that is all that remains to be done. Once the two subarrays are both sorted, the entire array is automatically sorted. This is true because of the condition — guaranteed by the partition step — that all elements in the first half of the array are less than or equal to all the elements in the second half of the array. Not convinced? Think about it! Or, consider the following analogy: a school teacher wishes to arrange test papers in alphabetical order. The papers are divided into two piles (partitioning step) with all papers in the left-hand pile belonging to students whose names begin with letters A to M, and all papers in the right-hand pile belonging to students with names beginning with letters N to Z. Now, if the left-hand pile is arranged (by whatever method) into alphabetical order and likewise the right-hand pile, then all that remains to put the whole collection into alphabetical order is to place the left-hand pile on top of the right-hand pile.

To continue the Quicksort algorithm, one applies the basic step to both subarrays obtained from the first partitioning step. That will produce in each case two new subarrays (or better, sub-subarrays), to which the partitioning process is applied in turn. Since we started with a finite number of elements in array A, sooner or later this will produce sub-sub...subarrays with 0 elements. Such subarrays are sorted by default. Thus, they need not be partitioned any further. Moreover, when both subarrays of a

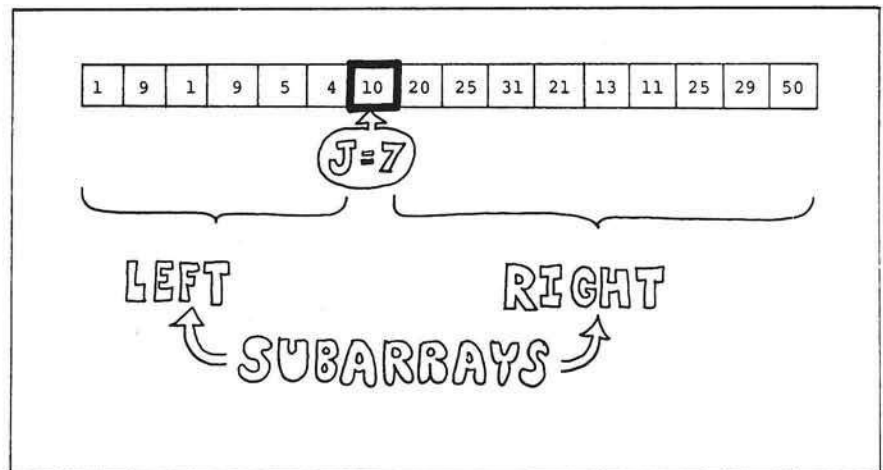


Figure 7
Partition step complete A(7) in correct position.

procedure

Partition(

var A: array[1..N+1] of integer;
Lower, Upper: integer;
var J: integer);

var

Value, Temp: integer;

begin

if Lower < Upper then begin

I := Lower; {Lower bound in A for partition step}
J := Upper; {Upper bound in A for partition step}
Value := A(Lower); {Comparison value for partitioning}

while I < J do begin {Partitioning loop}

repeat {Find element in right half to switch}
J := J-1
until A(J) <= Value;

repeat {Find element in left half to switch}
I := I+1
until A(I) >= Value;

if I <= J then begin {Perform the switch}

Temp := A(J);
A(J) := A(I);
A(I) := Temp

end {of if I <= J}

end {of while I < J}

A(Lower) := A(J); {Insert A(Lower) into its }
A(J) := Value; {correct final position in A}

end {of if Lower < Upper}

end {of Procedure Partition};

Figure 8

procedure

```
Sort(
  var A: array[1..N+1] of integer;
      Lower,Upper: integer);

var
  J: integer;

begin
  Partition(A,Lower,Upper,J); {Partition A between }
                             {A(Lower) and A(Upper) }
  Sort(A,Lower,J-1);         {Sort the "left" subarray }
  Sort(A,J+1,Upper);         {Sort the "right" subarray }

end {of Procedure Sort};
```

Figure 9

given subarray reach this state, they form together with their partition element a sorted subarray, which may then be ignored while the remaining unsorted subarrays are processed. Eventually, the original two subarrays will have been sorted and voila!, A will have been sorted. Figure 9 shows the implementation of this scheme as a Pascal procedure must be invoked from outside itself with initial values for Lower and Upper, which are presumably 1 and N, in most cases. Once it gets going, it calls itself on behalf of the subarrays, and the sub-subarrays, etc. until it completely sorts A. Figure 10 shows the progress of the sort as applied to a small array, with $N=8$. Study it carefully. Figure 11 presents the calling structure to Sort for the array in figure 10. The root of the tree represents the original call to Sort from outside. The interior nodes of the tree represent calls to Sort from within itself. Each node is labeled with the values of Lower and Upper which were passed on the corresponding call. The leaves of the tree represent calls to Sort in which the passed values of Lower and Upper correspond to subarrays with 0 elements. Such subarrays are already sorted and "nothing" will happen on these calls.

EXERCISE: Determine whether or not the Partition procedure may be modified to return whenever the passed array has either 0 or 1 elements. If so, make the necessary changes to the code.

The recursive implementation of Quicksort is without a doubt one of

the most "beautiful" algorithms yet devised in any branch of computer science. Unfortunately, the performance of Quicksort in such an implementation, even though superior to most N^2 algorithms, is still not quite as good as it could be. We shall not attempt to explain the technical reasons for this, other than to say that recursion involves more than a modicum of overhead. However, we shall attempt to formulate the algorithm in a non-recursive or iterative fashion for comparison.

Now look back at the recursive implementation of Quicksort shown in Figure 9. Since Sort calls itself, this means that the variable J, which is used locally within Sort, must be given a different "incarnation" on each call. Otherwise, the recursive calls would cause its former value to be lost, which in turn would mean that the procedure would get mixed up about where the subarrays began and ended. In languages, such as Pascal, which support recursive procedures, the uniqueness of J on each call is guaranteed. In a language like BASIC, there aren't even procedures, let alone recursive ones! Thus, in such a language, we must "fake it" in some way or another.

What is it about the variable J that's so important? It remembers the dividing point between the two subarrays determined by any partition step. This enables the two halves to be sorted separately by successive calls to Sort. Another way to approach matters would be to save information about subarrays

that still need sorting and retrieve it as necessary. An appropriate data structure for preserving such information is a stack. The Lower and Upper values for one "half" of a partition may be saved by pushing them onto the stack, while the other "half" is being sorted. When the other half has been completely sorted, the Lower and Upper values for the saved half may be popped off the stack and the sorting of that half commenced. Of course while sorting a given half, new pairs of bounds for smaller subarrays will be determined and bounds for one subarray of each such pair will in turn be pushed onto the stack. If a point is reached at which we try to pop the bounds of a subarray from the stack, and find that the stack is empty, then we will know that the original array is completely sorted. As a performance enhancement, we shall always sort the smaller of any given pair of subarrays first. This is in distinction to the algorithm of Figure 9, which always sorts the left subarray first. Sorting the smaller subarray first will cause a minimum number of entries to be saved on the stack.

The actual code of an iterative implementation of the Quicksort algorithm is presented in Listing 5, using APPLE Integer BASIC.

Sorting Implemented

The APPLE II Integer BASIC programs of Listings 1-5 provide implementations of visual sorts for the following five methods: Bubble sort, straight insertion sort, selection sort, Shell sort, and Quicksort. The visual display arranges the array to be sorted as a table of up to 100 positive two digit integers — the user may request fewer if so desired to speed up the completion of the algorithm. The basic table using the random number generator for INTEGER BASIC. For skeptical viewers, the values 0 to N may be generated in a permuted order and filled into the first $N+1$ slots of the tableau. The modification needed in order to accomplish this is shown in Figure 12. Figure 13 shows a typical tableau, this one prior to the beginning of Shellsort. Notice that extra information is displayed in the small area surrounding the display. By studying the listing and carefully

A								Call	
---								-----	
10	9	1	13	5	21	7	20	Partition(A,1,8);	
10	9	1	7	5	21	13	20		
5	9	1	7	10	21	13	20		
5	9	1	7	10	21	13	20	Partition(A,1,4);	
5	1	9	7	10	21	13	20		
1	5	9	7	10	21	13	20		
1	5	9	7	10	21	13	20	Partition(A,1,1);	
1	5	9	7	10	21	13	20		
1	5	9	7	10	21	13	20	Partition(A,3,4);	
1	5	7	9	10	21	13	20		
1	5	7	9	10	21	13	20	Partition(A,3,3);	
1	5	7	9	10	21	13	20	Partition(A,5,4);	
1	5	7	9	10	21	13	20	Partition(A,6,8);	
1	5	7	9	10	20	13	21		
1	5	7	9	10	20	13	21	Partition(A,6,7);	
1	5	7	9	10	13	20	21		
1	5	7	9	10	13	20	21	Partition(A,6,6);	
1	5	7	9	10	13	20	21	Partition(A,8,7);	
1	5	7	9	10	13	20	21	Partition(A,9,8);	

Figure 10
Complete trace of Quicksort for
N=8 boxed entries are known to be
in the correct slot.

monitoring this information, extra insight into the nature of the algorithms may be gained.

All values generated are positive and less than 100. This is done because of horizontal space constraints in the display and does not reflect any inherent limitations in the algorithms themselves.

The programs each carry out one of the sorting algorithms. As the array is sorted, the values displayed on the screen are modified to reflect the changes taking place internally. Various devices are used to highlight this: some visual and some aural. The audio effects are programmed using the Programmer's Aid ROM. Thus, you may have to remove or modify certain statements in order to run the programs, if you don't own PA.

Each time a number is moved from one place to another in the array, that value is highlighted in the display. This is accomplished by momentarily displaying the value in reverse video, then switching back to normal mode. If your APPLE has been modified for lower case, this probably won't work. You can get a good idea of how each algorithm does its job just by watching the pattern of flashes on the screen.* In addition to this, as mentioned above, each sort prints on the border of the display some additional information about what is happening. Each program begins with a prologue giving the name of the sort and prompting the user for the number of elements to be sorted. The value of PDL(1) is used by the programs to control the speed at which the display is generated. Thus to slow down the

progress of the program, simply turn up the PDL(1) control.

While each algorithm is in progress, two tones will be sounded periodically. One tone is generated each time an array element is copied from one place to another, that is, for each interchange. A different tone is sounded whenever an array element is compared to another or to a fixed value, that is, for each comparison. Listening to the pattern of sounds thus produced gives a very definite auditory tattoo to each algorithm. The calls to Programmer's Aid which produce these tones are localized in subroutines to facilitate their removal or replacement should you not have the PA ROM. For example, in the bubble sort demo, you may defeat the sounds by inserting the two statements:

```
901 RETURN
951 RETURN
```

Even if you do have PA, you may want to use these statements in order to (a) speed up the program a little or (b) hear only comparisons or only interchanges.

*NOTE: If you stop the program with a Control-c at just the right (or wrong — depending on your point of view) moment, you may find that everything is being displayed in reverse video. To return to normal display mode, simply type:

```
POKE 50,255
```

and all should be well.

I hope that these demonstrations will enhance your understanding and enjoyment of sorting algorithms you may wish to implement similar demos for other sorting algorithms, or if you are very ambitious, how about a way of having the various algorithms swap in and out while the same array is sorted in stages? Happy viewing!

A complete package of twenty demonstration programs, including the ones listed here and variations upon them may be obtained for \$14.95 on a single diskette by writing to the author.

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Ann Arbor, MI 48105

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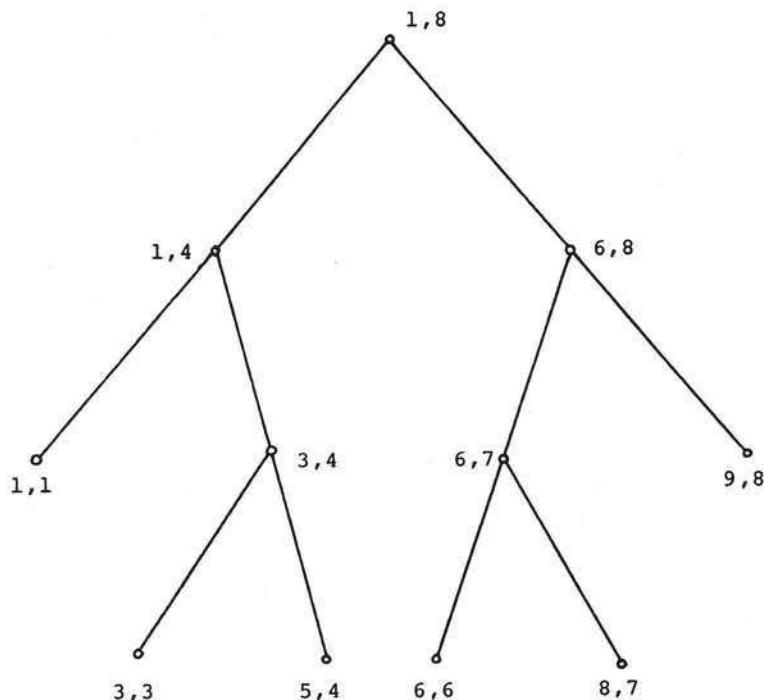


Figure 11

Call tree for Figure 10. Each node is labelled with the values of Lower, Upper for the corresponding call. The levels of the tree correspond to the depth of the recursion.

	0	1	2	3	4	5	6	7	8	9
0!	12	72	14	68	54	23	32	3	56	24
1!	44	26	41	0	87	67	8	81	39	39
2!	3	26	60	64	35	20	39	78	65	26
3!	16	17	99	69	81	88	65	32	5	68
4!	37	44	32	89	65	37	20	38	84	77
5!										
6!										
7!										
8!										
9!										

SHELL SORT J= 10
SPAN = 10 A(J)=44

Figure 13

Just before the start of the shell sort. Fifty elements are being sorted.

```

80 For I = 0 TO N: A(I) =: NEXT I
90 For I = 0 TO N
100 L = RND (N + 1): IF A(L)
    >= 0 THEN 100
105 A(L) = I: X = L: GOSUB
    DISPLAY
110 NEXT I

```

Figure 12

Modification to Display generation: will seed the initial array with exactly the numbers 0 to N in some permuted order.

Richard Vile was educated in mathematics, earning a B.S. degree from Michigan State University and a Ph.D. from Cornell University.

Richard taught mathematics at Eastern Michigan University from 1970 - 1977. While at Eastern, he became interested in computers and began studying and teaching computer science.

In early 1978, he took a leave of absence from, E.M.U. in order to work for SYCOR, Inc. and Ann Arbor manufacturer of distributed data processing computer systems. He enjoyed the work so much that he did not return to the academic world. He is currently employed by the same company, known as Northern Telecom Systems Corporation, where he is engaged in the development of languages and language related software: compilers, assemblers, linkage editors, etc.

Richard owns an APPLE II computer, which he puts to good use preparing articles for MICRO and other personal computing journals.

Richard C. Vile, Jr.
3467 Yellowstone Dr.
Ann Arbor, Michigan 48105

Continued on page 24...

Software for the Apple II



SUPER CHECKBOOK—a program designed to be an electronic supplement to your checkbook register. It's disk oriented and allows information to be displayed on the video screen or printer. It's super fast in sorting and retrieving information and totals. As an added bonus the program can optionally provide bar graphs to screen and/or printer. The program performs all standard check register operations, i.e. reconciliation. Minimum requirements are Disk II and only 32K RAM memory if Applesoft is in ROM; \$19.95.

ADDRESS FILE GENERATOR—a program that gives you complete control over a name and address file at a very low price. The power and flexibility of this software system is unmatched even in programs costing much more. You are allowed up to eleven fields in each record and you can search and sort on any of these fields. In fact you can sort up to three fields at once. The program contains a powerful print format routine which allows you to print out any field in any format you wish. Minimum requirements are Disk II and only 32K RAM memory if Applesoft is in ROM; \$19.95

WORLD OF ODYSSEY—an adventure game to which all others must be compared. It's by far the most complex game for the Apple II. It will probably drive you crazy and take several months of play to completely traverse this world. You have 353 rooms on 6 different levels to explore with myriads of treasures and dangers. The program allows you to stop play and to optionally save where you are so that you can resume play at a later time without having to repeat previous explorations. It's been called the best adventure game yet! Minimum requirements are Disk II with 48K RAM and Applesoft II in ROM; \$19.95.

REAL ESTATE ANALYSIS PROGRAM—The Real Estate Analysis Program provides the user with three features. a) A powerful real estate investment analysis for buy/sell decisions and time to hold decisions for optimal rental/commercial investments. b) Generation of complete amortization schedules. c) Generation of depreciation schedules. All three features are designed for video screen or printer output. In addition, the program will plot; cash flow before taxes vs. years, cash flow after taxes vs. years, adjusted basis vs. years, capital gains vs. years, pre-tax proceeds vs. years, post-tax proceeds vs. years, and return on investment (%) vs. years. Minimum requirement Applesoft II, 16K; \$14.95.

DYNAMAZE—a dazzling new real-time game. You move in a rectangular game grid, drawing or erasing walls to reflect balls into your goal (or to deflect them from your opponent's goal). Every ball in your goal is worth 100 points, but you lose a point for each unit of elapsed time and another point for each time unit you are moving. Control the speed with a game paddle: play as fast as ice hockey or as slowly and carefully as chess. Back up and replay any time you want to; it's a reversible game. Integer Basic (plus machine language); 32K; \$9.95

ULTRA BLOCKADE—the standard against which other versions have to be compared. Enjoy Blockade's superb combination of fast action (don't be the one who crashes) and strategy (the key is accessible open space—maximize yours while minimizing your opponent's). Play against another person or the computer. New high resolution graphics lets you see how you filled in an area—or use reversibility to review a game in slow motion (or at top speed, if that's your style). This is a game that you won't soon get bored with! Integer Basic (plus machine language); 32K; \$9.95.

What is a **REVERSIBLE GAME**? You can stop the play at any point, back up and then do an "instant replay", analyzing your strategy. Or back up and resume the game at an earlier point, trying out a different strategy. Reversibility makes learning a challenging new game more fun. And helps you become a skilled player sooner.

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```

:PR40
:LIST

```

```

5 DIM A(100)
6 KBD=-16384:CLR=-16368:TITLE=
  500:INTRO=1000
7 DISPLAY=400:WAIT=800:COMPARE=
  900:INTERCHANGE=950
8 MUSIC=-10473:TIME=766:TIMBRE=
  765:PITCH=767
10 TEXT : CALL -936
20 GOSUB INTRO
50 GOSUB TITLE
90 FOR R=0 TO 100:A(R)=32767: NEXT
  R
100 FOR I=0 TO N
105 A(I)= RND (100):X=I: GOSUB
  DISPLAY
108 IF N=0 THEN 150
110 NEXT I
150 FOR I=1 TO NUM-1
152 FLAG=0
155 FOR J=0 TO N-I
158 FOR T=0 TO PDL (1): NEXT T
159 GOSUB COMPARE
160 IF A(J)<=A(J+1) THEN 200
163 X=100: POKE 50,127:A(100)=A(
  J): GOSUB DISPLAY
165 KEEP=A(J): GOSUB INTERCHANGE:
  X=J
170 POKE 50,63
173 A(J)=A(J+1): GOSUB DISPLAY:
  GOSUB INTERCHANGE: POKE 50
  ,255
175 GOSUB DISPLAY:X=J+1: POKE 50
  ,63
180 A(J+1)=KEEP: GOSUB DISPLAY:
  GOSUB INTERCHANGE: POKE 50
  ,255
185 GOSUB DISPLAY
190 FLAG=1
195 KEY= PEEK (KBD): IF KEY<128
  THEN 200
196 POKE CLR,0: GOSUB WAIT
200 NEXT J
202 IF FLAG=0 THEN 208
205 NEXT I
208 VTAB 24: TAB 21: PRINT "FINISHE
  ";
210 IF PEEK (KBD)<128 THEN 210
220 POKE CLR,0: CALL -936: GOTO
  20
500 TEXT : CALL -936
510 VTAB 1: FOR I=0 TO 9: TAB 7

```

```

  +3*I: PRINT I: NEXT I
515 VTAB 2: TAB 7: FOR I=0 TO 9
  : PRINT "----": NEXT I
520 FOR J=0 TO 9: VTAB 3+2*J: TAB
  4: PRINT J;"! " : NEXT J
525 VTAB 23: TAB 1: PRINT "TEMP="
  : TAB 20
528 PRINT "BUBBLE SORT"
530 RETURN
600 COL=X MOD 10
610 ROW=X/10
620 VTAB 2*ROW+3: TAB 7+3*COL
630 IF A(X)<10 THEN PRINT " ";
635 PRINT A(X);
640 RETURN
800 IF KEY<> ASC("Q") THEN 810
805 TEXT : CALL -936: END
810 VTAB 2*ROW+3: TAB 6+3*COL: PRINT
  ">";
815 KEY= PEEK (KBD): IF KEY<128
  THEN 810
817 VTAB 2*ROW+3: TAB 6+3*COL: PRINT
  " ";
820 POKE CLR,0: RETURN
900 REM *** TO REMOVE SOUND FOR COM
  PARISONS - INSERT 901 RETURN ***
902 POKE PITCH,10: POKE TIME,5:
  CALL MUSIC
905 FOR DE=1 TO PDL (1): NEXT DE
910 RETURN
950 REM *** TO REMOVE SOUND FOR INT
  ERCHANGES - INSERT 951 RETURN **
  *
952 POKE PITCH,49: POKE TIME,3:
  CALL MUSIC
955 FOR DE=1 TO PDL (1): NEXT DE
960 RETURN
1000 VTAB 10: TAB 5: PRINT "I WILL SO
  RT UP TO 100 POSITIVE"
1001 TAB 5: PRINT "INTEGERS INTO ASCE
  NDING"
1002 TAB 5: PRINT "ORDER USING THE BU
  BBLE SORT."
1008 VTAB 15: TAB 10: INPUT "VALUE OF
  N PLEASE",NUM:N=NUM-1
1010 IF NUM<=100 THEN RETURN
1015 TAB 10
1020 PRINT "TOO BIG!!!!!!": GOTO
  1000

```

Listing 2
INSERTION SORT

```

>PR#0
>LIST
0 I=J=Y=N
5 DIM A(99)
6 KBD=-16384:CLR=-16368:TITLE=
  500:INTRO=1000
7 DISPLAY=600:WAIT=800:COMPARE=
  900:INTERCHANGE=950
8 MUSIC=-10473:TIME=766:TIMBRE=
  765:PITCH=767
9 DELAY=975:ERASE=650
10 TEXT : CALL -936
20 GOSUB INTRO
50 GOSUB TITLE
90 FOR R=0 TO 99:A(R)=32767: NEXT
  R
100 FOR I=0 TO N
105 A(I)= RND (100):X=I: GOSUB
  DISPLAY
108 IF N=0 THEN 150
110 NEXT I
150 FOR I=1 TO N
151 IF I>N THEN 206:Y=A(I)
152 VTAB 23: TAB 32: PRINT "I="
  ;; IF I<10 THEN PRINT " ";
  PRINT I
153 VTAB 24: TAB 32: PRINT "Y="
  ;; IF Y<10 THEN PRINT " ";
  PRINT Y
154 GOSUB INTERCHANGE
155 FOR J=I-1 TO 0 STEP -1
156 GOSUB DELAY:KEY= PEEK (KBD)
  : IF KEY<128 THEN 159
158 POKE CLR,0: GOSUB WAIT
159 GOSUB COMPARE
160 IF Y>A(J) THEN 202
163 A(J+1)=A(J)
166 GOSUB INTERCHANGE
168 POKE 50,63
175 X=J: GOSUB DISPLAY: GOSUB DELAY
178 X=J+1: GOSUB DISPLAY: GOSUB
  DELAY
180 POKE 50,255: GOSUB DISPLAY:
  GOSUB DELAY
185 X=J: GOSUB ERASE
200 NEXT J
202 A(J+1)=Y
203 POKE 50,63:X=J+1: GOSUB DISPLAY
204 GOSUB INTERCHANGE
205 POKE 50,255: GOSUB DISPLAY
206 NEXT I
208 VTAB 24: TAB 15: PRINT "FINISHE
  "
210 IF PEEK (KBD)<128 THEN 210
220 POKE CLR,0: CALL -936: GOTO
  20
500 TEXT : CALL -936
510 VTAB 1: FOR I=0 TO 9: TAB 7
  +3*I: PRINT I:; NEXT I
515 VTAB 2: TAB 7: FOR I=0 TO 9
  : PRINT "---";; NEXT I
520 FOR J=0 TO 9: VTAB 3+2*J: TAB
  4: PRINT J:"! ";; NEXT J
525 VTAB 23: TAB 13: PRINT "INSERTIO
  N SORT"
530 RETURN
600 COL=X MOD 10
610 ROW=X/10
620 VTAB 2*ROW+3: TAB 7+3*COL
630 IF A(X)<10 THEN PRINT " ";
635 PRINT A(X);
640 RETURN
650 COL=X MOD 10:ROW=X/10
655 VTAB 2*ROW+3: TAB 7+3*COL
660 PRINT " ";
670 RETURN
800 IF KEY<> ASC("Q") THEN 810
805 TEXT : CALL -936: END
810 KEY= PEEK (KBD): IF KEY<128
  THEN 810
820 POKE CLR,0: RETURN
900 REM *** TO REMOVE SOUND FOR COM
  PARISONS - INSERT 901 RETURN ***
902 POKE PITCH,10: POKE TIME,5:
  CALL MUSIC
905 GOSUB DELAY
910 RETURN
950 REM *** TO REMOVE SOUND FOR INT
  ERCHANGES - INSERT 951 RETURN **
  *
952 POKE PITCH,49: POKE TIME,3:
  CALL MUSIC
955 GOSUB DELAY
960 RETURN
975 FOR DE=1 TO PDL (1): NEXT DE
980 RETURN
1000 VTAB 10: TAB 5: PRINT "I WILL SO
  RT UP TO 100 POSITIVE"
1001 TAB 5: PRINT "INTEGERS INTO ASCE
  NDING"
1002 TAB 5: PRINT "ORDER USING THE IN
  SECTION SORT."
1008 VTAB 15: TAB 10: INPUT "VALUE OF
  N PLEASE",NUM:N=NUM-1
1010 IF N>=0 THEN 1013
1012 TEXT : CALL -936: END
1013 IF NUM<=100 THEN RETURN
1015 TAB 10
1020 PRINT "TOO BIG!!!!!!": GOTO
  1000

```


Listing 3
SELECTION SORT

```

>PR#0
>LIST
0 I=J=Y=N
5 DIM A(99)
6 KBD=-16384:CLR=-16368:TITLE=
  500:INTRO=1000
7 DISPLAY=600:WAIT=800:CMP=900
  :INT=950
8 MUSIC=-10473:TIME=766:TIMBRE=
  765:PITCH=767
9 DELAY=975:ERASE=650
10 TEXT : CALL -936
20 GOSUB INTRO
50 GOSUB TITLE
100 FOR I=0 TO N
105 A(I)= RND (100):X=I: GOSUB
  DISPLAY
110 NEXT I
150 FOR I=0 TO N-1
151 MAX=0
152 VTAB 23: TAB 32: PRINT "I="
  ;; IF I<10 THEN PRINT " ";
  PRINT I
155 FOR J=1 TO N-1
156 KEY= PEEK (KBD): IF KEY<128
  THEN 158
157 POKE CLR,0: GOSUB WAIT
158 GOSUB DELAY
159 GOSUB CMP
160 IF A(J)<=A(MAX) THEN 200
163 MAX=J
165 VTAB 24: TAB 32: PRINT "M="
  ;; IF MAX<10 THEN PRINT " ";
  ;; PRINT MAX;
168 POKE 50,63
175 X=J: GOSUB DISPLAY
178 POKE 50,255
185 X=J: GOSUB DISPLAY
200 NEXT J
202 TEMP=A(MAX): GOSUB INT
203 A(MAX)=A(N-I):X=MAX: POKE 50
  ,63: GOSUB DISPLAY: GOSUB INT:
  POKE 50,255: GOSUB DISPLAY
204 A(N-I)=TEMP:X=N-I: POKE 50,
  63: GOSUB DISPLAY: GOSUB INT:
  POKE 50,255: GOSUB DISPLAY
212 NEXT I
215 VTAB 24: TAB 15: PRINT "FINISHED
  ";
218 IF PEEK (KBD)<128 THEN 218
220 POKE CLR,0: CALL -936: GOTO
  20
500 TEXT : CALL -936
510 VTAB 1: FOR I=0 TO 9: TAB 7
  +3*I: PRINT I;; NEXT I
515 VTAB 2: TAB 7: FOR I=0 TO 9
  : PRINT "----";; NEXT I
520 FOR J=0 TO 9: VTAB 3+2*J: TAB
  4: PRINT J;"! ";; NEXT J
525 VTAB 23: TAB 13: PRINT
  "SELECTION
  SORT"
530 RETURN
600 COL=X MOD 10
610 ROW=X/10
620 VTAB 2*ROW+3: TAB 7+3*COL
630 IF A(X)<10 THEN PRINT " ";
635 PRINT A(X);
640 RETURN
800 IF KEY# ASC("Q") THEN 810
805 TEXT : CALL -936: END
810 IF PEEK (KBD)<128 THEN 810
815 POKE CLR,0
849 RETURN
900 REM *** TO REMOVE SOUND FOR COM
  PARISONS - INSERT 901 RETURN ***
902 POKE PITCH,10: POKE TIME,5:
  CALL MUSIC
905 GOSUB DELAY
910 RETURN
950 REM *** TO REMOVE SOUND FOR INT
  ERCHANGES - INSERT 951 RETURN **
  *
952 POKE PITCH,49: POKE TIME,3:
  CALL MUSIC
955 GOSUB DELAY
960 RETURN
975 FOR DE=1 TO PDL (1): NEXT DE
999 RETURN
1000 VTAB 10: TAB 5: PRINT "I WILL SO
  RT UP TO 100 POSITIVE"
1001 TAB 5: PRINT "INTEGERS INTO ASCE
  NDING"
1002 TAB 5: PRINT "ORDER USING THE SE
  LECTION SORT."
1008 VTAB 15: TAB 10: INPUT "VALUE OF
  N PLEASE",N
1010 IF N>0 THEN 1013
1011 TEXT : CALL -936: END
1013 IF N<=99 THEN RETURN
1015 TAB 10
1020 PRINT "TOO BIG!!!!!": GOTO
  1000

```

Listing 4
SHELL SORT

>PR#0
>LIST

```

100 DIM A(99),INCS(5)
105 MUSIC=-10473:PITCH=767:TIME=
766:TIMBRE=765: POKE TIMBRE,
32
110 KBD=-16384:CLR=-16368:TITLE=
400:INTRO=1000
120 DISPLAY=500:WAIT=800:CMP=900
:INT=950
125 DELAY=975:ERASE=550
130 TEXT : CALL -936
140 GOSUB INTRO
150 GOSUB TITLE
160 FOR I=0 TO N
170 A(I)= RND (100):X=I: GOSUB
DISPLAY
180 NEXT I
190 INCS(1)=10:INCS(2)=6:INCS(3)
)=4:INCS(4)=2:INCS(5)=1
200 FOR I=1 TO 5
210 SPAN=INCS(I)
211 IF SPAN>N THEN 370
215 VTAB 24: TAB 12: PRINT "SPAN="
;
216 IF SPAN<10 THEN PRINT " ";:
PRINT SPAN;
220 FOR J=SPAN TO N
230 Y=A(J): GOSUB INT
233 VTAB 23: TAB 28: PRINT "J= "
;: IF J<10 THEN PRINT " ";:
PRINT J
235 TAB 26: PRINT "A(J)=";: IF
A(J)<10 THEN PRINT " ";
236 POKE 50,63: PRINT A(J);: POKE
50,255
240 FOR K=J-SPAN TO 0 STEP -SPAN
245 GOSUB CMP
250 IF Y>A(K) THEN 320
260 POKE 50,63
265 GOSUB INT
270 A(K+SPAN)=A(K)
280 X=K+SPAN: GOSUB DISPLAY
285 KEY= PEEK (KBD): IF KEY<128
THEN 290
287 POKE CLR,0: GOSUB WAIT
290 GOSUB DELAY
300 POKE 50,255: GOSUB DISPLAY
305 X=K: GOSUB ERASE
310 NEXT K
320 POKE 50,63
325 GOSUB INT
330 A(K+SPAN)=Y:X=K+SPAN: GOSUB
DISPLAY
340 GOSUB DELAY
350 POKE 50,255: GOSUB DISPLAY
360 NEXT J
370 NEXT I
380 VTAB 24: TAB 12: PRINT "FINISHE
"
390 IF PEEK (KBD)<128 THEN 390
395 POKE CLR,0: CALL -936: GOTO

140
400 TEXT : CALL -936
420 VTAB 1: FOR I=0 TO 9: TAB 7
+3*I: PRINT I;: NEXT I
430 VTAB 2: TAB 6: FOR I=0 TO 9
: PRINT "----";: NEXT I
440 FOR J=0 TO 9: VTAB 3+2*J: TAB
4: PRINT J;"! ";: NEXT J
450 VTAB 23: TAB 10: PRINT " SHELL S
ORT"
460 RETURN
500 COL=X MOD 10
510 ROW=X/10
520 VTAB 2*ROW+3: TAB 7+3*COL
530 IF A(X)<10 THEN PRINT " ";
540 PRINT A(X);
549 RETURN
550 COL=X MOD 10:ROW=X/10
555 VTAB 2*ROW+3: TAB 7+3*COL
560 PRINT " ";
599 RETURN
800 IF KEY<> ASC("Q") THEN 810
805 TEXT : CALL -936: END
810 KEY= PEEK (KBD): IF KEY<128
THEN 810
820 POKE CLR,0: RETURN
900 REM *** TO REMOVE SOUND FOR COM
PARISONS - INSERT 901 RETURN ***
902 POKE PITCH,10: POKE TIME,3:
CALL MUSIC
905 GOSUB DELAY
949 RETURN
950 REM *** TO REMOVE SOUND FOR INT
ERCHANGES - INSERT 951 RETURN **
*
952 POKE PITCH,49: POKE TIME,3:
CALL MUSIC
955 GOSUB DELAY
960 RETURN
975 FOR DE=1 TO PDL (1): NEXT DE
999 RETURN
1000 VTAB 10: TAB 5: PRINT "I WILL SO
RT UP TO 100 POSITIVE"
1010 TAB 5: PRINT "INTEGERS INTO ASCE
NDING"
1020 TAB 5: PRINT "ORDER USING THE SH
ELL SORT"
1030 VTAB 15: TAB 10: INPUT "VALUE OF
N PLEASE",N
1040 IF N>0 THEN 1060: CALL -936
: END
1060 IF N<=99 THEN RETURN
1070 TAB 10
1080 PRINT "TOO MANY!!!!!!": GOTO
1000
2000 POKE CLR,0
2010 KEY= PEEK (KBD): IF KEY<128
THEN 2010
2020 POKE CLR,0: RETURN

```

Listing 5
QUICKSORT

```

>LIST
5 DIM A(200),STACK(24)
6 KBD=-16384:CLR=-16388:TITLE=
  5000:INTRO=10000
7 DISPLAY=6000:CMF=6500:DELAY=
  6600
8 MUSIC=-10473:TIME=768:TIMBRE=
  765:PITCH=767
10 TEXT:CALL -936
20 GOSUB INTRO
50 GOSUB TITLE
100 FOR I=0 TO N
105 A(I)=RND(100):X=I:GOSUB
  DISPLAY
110 NEXT I
115 A(N+1)=32767
120 P=0:Q=N
125 TOP=0:MAXTP=0
130 IF P>=Q THEN 170
135 K=Q+1
137 VTAB 23: TAB 34: PRINT "P= "
  ;: IF P<100 THEN PRINT " ";
  : IF P<10 THEN PRINT " ";: PRINT
  P
138 TAB 34: PRINT "Q= ";: IF K<
  100 THEN PRINT " ";: IF K<10
  THEN PRINT " ";: PRINT K)
139 GOSUB 1145
140 IF J-P<Q-J THEN 150
143 GOSUB 400
144 GOTO 160
150 GOSUB 500
160 TOP=TOP+2
161 IF TOP>MAXTP THEN MAXTP=TOP
162 VTAB 24: TAB 23: PRINT (TOP/
  2);
163 IF PEEK(KBD)>=128 THEN GOSUB
  8000
165 GOTO 130
170 IF TOP=0 THEN 208
175 Q=STACK(TOP):P=STACK(TOP-1)
  :TOP=TOP-2
176 GOSUB 7500
177 VTAB 24: TAB 23: PRINT (TOP/
  2);
179 IF PEEK(KBD)>=128 THEN GOSUB
  8000
180 GOTO 130
208 VTAB 24: TAB 4: PRINT "FINISHED"
  ;
209 TAB 15: PRINT "MAXTOP= ";(MAXTP/
  2);
210 IF PEEK(KBD)<128 THEN 210
220 POKE CLR,0:CALL -936:GOTO
  20
400 STACK(TOP+1)=P
405 STACK(TOP+2)=J-1
410 P=J+1
415 GOSUB 7000
499 RETURN
500 STACK(TOP+1)=J+1
505 STACK(TOP+2)=Q
510 Q=J-1
515 GOSUB 7000
599 RETURN
1145 V=A(P):I=P:J=K
1160 J=J-1: IF A(J)<=V THEN 1170
1162 GOSUB DELAY
1165 GOSUB CMF: GOTO 1160
1170 I=I+1: IF A(I)>=V THEN 1180
1172 GOSUB DELAY
1175 GOSUB CMF: GOTO 1170
1180 IF J<=I THEN 1200
1185 TEMP=A(I)
1186 A(I)=A(J):X=I: GOSUB DISPLAY
1188 A(J)=TEMP:X=J: GOSUB DISPLAY
1195 IF PEEK(KBD)<128 THEN 1160
1196 GOSUB 8000
1199 GOTO 1160
1200 A(P)=A(J):X=P: GOSUB DISPLAY
1202 A(J)=V:X=J: GOSUB DISPLAY
1999 RETURN
5000 TEXT:CALL -936
5010 VTAB 1: FOR I=0 TO 9: TAB 7
  +3*I: PRINT I;; NEXT I
5020 VTAB 2: TAB 7: FOR I=0 TO 9
  : PRINT "----";: NEXT I
5030 FOR J=0 TO 19: VTAB 3+J: TAB
  3
5035 IF J<10 THEN PRINT " ";: PRINT
  J;"! ";: NEXT J
5040 VTAB 23: TAB 3: PRINT "QUICKSORT
  PARTITION=====>"
5045 VTAB 24: TAB 15: PRINT "PENDING:
  0";
5050 VTAB 5: TAB 39: PRINT "S": TAB
  39: PRINT "T": TAB 39: PRINT
  "A": TAB 39: PRINT "C": TAB
  39: PRINT "K"
5060 FOR R=10 TO 22: TAB 39: PRINT
  ".": NEXT R
5099 RETURN
6000 COL=X MOD 10
6010 ROW=X/10
6020 POKE 50,63
6030 VTAB ROW+3: TAB 7+3*COL
6040 IF A(X)<10 THEN PRINT " ";
6050 PRINT A(X);
6060 POKE 50,255
6070 VTAB ROW+3: TAB 7+3*COL
6080 IF A(X)<10 THEN PRINT " ";
6090 PRINT A(X);
6100 REM *** TO REMOVE SOUND FOR INT
  ERCHANGES - INSERT 6101 RETURN *
  **
6110 POKE PITCH,49: POKE TIME,3:
  CALL MUSIC

```



```

6199 RETURN
6500 REM *** TO REMOVE SOUND FOR COM
PARISONS - INSERT 6501 RETURN **
*
6510 POKE PITCH,10: POKE TIME,5:
CALL MUSIC
6599 RETURN
6600 FOR DE=0 TO PDL (1): NEXT DE
6699 RETURN
7000 VTAB 21-TOP: TAB 37
7005 TOS=STACK(TOP+1):NOS=STACK(
TOP+2)
7010 IF NOS<100 THEN PRINT " ";
IF NOS<10 THEN PRINT " ";
PRINT NOS
7015 TAB 37: IF TOS<100 THEN PRINT
" "; IF TOS<10 THEN PRINT
" "; PRINT TOS;
7499 RETURN
7500 VTAB 21-TOP: TAB 37: PRINT
" " : TAB 37: PRINT " ";

```

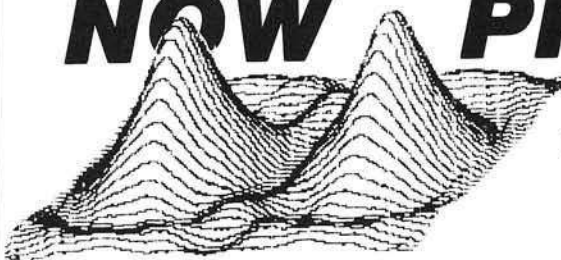
```

7999 RETURN
8000 POKE CLR,0
8005 IF PEEK (KBD)<128 THEN 8005

8010 POKE CLR,0
8099 RETURN
10000 VTAB 10: TAB 5: PRINT "I WILL SO
RT UP TO 100 POSITIVE"
10010 TAB 5: PRINT "INTEGERS INTO ASCE
NDING"
10020 TAB 5: PRINT "ORDER USING HOARE'
S QUICKSORT."
10030 VTAB 15: TAB 10: INPUT "VALUE OF
N PLEASE",N
10040 IF N>0 THEN 10060
10050 TEXT : CALL -936: END
10060 IF N<=199 THEN RETURN
10070 TAB 10
10080 PRINT "TOO BIG!!!!!!": GOTO
10000

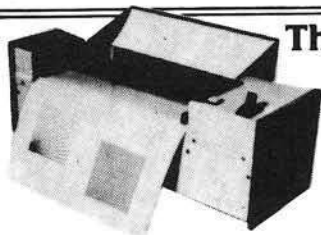
```

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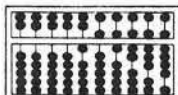
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A very inexpensive analog interface is presented that can be used with any microcomputer. Some PET oriented programs are provided, including a STAR ACE game, to show how the device may be utilized.

John Sherburne

When I bought my PET, one of the things I eventually wanted to do was to interface the computer to the outside world. Over the two years since then I have seen interface devices of one kind or another, but all of them have been fairly expensive, and most are designed for a single application. I have finally found one interface, however, which is cheap, simple enough for even the laziest Sunday solderer to build, and is useful for a variety of real world applications. By plugging in a joystick or two, arcade-type games can be created. If the interface is used to dense switch settings, educational programs or game show recreations can be easily made. Adding a potentiometer or thermistor as a sensor permits measurement of temperature, wind direction or other external conditions. All in all, it is the best way I have found for the PET owner with a tight budget to branch out into new areas.

The interface uses a single integrated circuit — an NE555 timer. The principle of operation is to hook up the timer as in Figure 1 so that it emits a pulse when triggered by the PET. The duration of the pulse depends upon the magnitude of the resistance, R1, in the circuit. By timing the pulse duration with the PET internal clock, the resistance can be measured. Thus, any device which translates an external quality into a resistance can be used as a sensor. Using the circuit requires three

elements: a 5 volt DC power supply, the 555-based timer and a sensor. If you don't already have a power supply there is no need to buy an expensive one just for this application. I found that a small kit such as the Jameco JE 200 is adequate, inexpensive (\$14.95) and can be put together in less than an hour. As for sensors, the cost and availability depend on what you want to do. A simple measure of displacement can be made with a potentiometer costing less than a dollar. Precision probes for temperature, on the other hand, may be expensive and hard to find. The third element, the NE555, costs about 60¢ and a four timer interface with board, wire, connectors and the like can be constructed for about \$10.

Interface to the PET is made through pins PA0 - PA7 of the parallel user port shown in Figure 2. These eight pins can be programmed for either input or output by changing the contents of memory location 59459 (E843). If bit n of that location is a zero, PA n will be an input pin. If bit n is a one, PA n will be an output pin. For example, POKE 59459, 15 will make pins PA0 — PA3 output and pins PA4 — PA7 input. Once programmed, the pins are read or driven via location 59471 (E84F). In this way the user port can be programmed so that one pin is used as output to trigger a 555 and another pin is used as input to sense the duration of the timer pulse. Since

there are eight pins, four 555s can be connected without resorting to encode/decode arrangements.

Figure 3 is a schematic of a four 555 interface. The interface is sufficient to handle two joysticks — each of which has two potentiometers or four individual sensors. Two NE556s could also be used since the 556 is a dual 555. The pin by pin connection for each of the 555s is as follows:

- 1 Connect to ground.
- 2 Trigger. Connect to output pin of users port. This pin is normally high (+5V). When brought momentarily to ground, it starts the 555 output pulse.
- 3 Output. Connect to users port input pin. This pin is normally low (ground). During the output pulse it is high.
- 4 Connect to +5V.
- 5 Connect to ground through bypass capacitor C2
- 6 Connect to +5V through sensor R1 and connect to ground through timing capacitor C1.
- 7 Connect to pin 6.
- 8 Connect to +5V.

Each of the four 555s in Figure 3

is connected the same way. The four trigger pins (pin 2) are connected to PA0 — PA3 and the four output pins (pin 3) are connected to PA4 — PA7. The PET ground is connected through R2 to the IC ground (pin 1).

The output pulse duration of the 555 is dependent both on R1 and C1. As C1 is increased in capacitance, the pulse is longer. A .01 yf capacitor works well for moderate sensor resistances (50K to 1 meg ohm). For lower resistances, a higher capacitance is needed. Capacitors must be high quality mylar for stability. The duration of the output pulse also increases as R1 increases. If there is no resistance at R1, that is, pin 7 is shorted to +5V, the pulse duration will be essentially zero. An open circuit between pins 5 and 7 will cause an almost unending pulse.

To measure the duration of the pulse, one of the timers associated with the parallel user port is accessed. The timer is two bytes long and decrements with every cycle of the PET clock (every microsecond). The least significant byte of the timer is at location 59464 (E848). It starts at 255, counts down to zero and recycles. The most significant byte is 59465. It starts at 255 and counts down each time 59464 reaches zero. The speed of the timer requires that machine language rather than BASIC be used to access it. Program 1 is a simple assembly language program which drives one pin of the user port low then high, starts the timer and waits for the end of the output pulse of the 555. The pulse length is then stored in locations 42 and 43 (2A and 2B). The pins to be used for output and input are determined by memory locations 40 and 41 (28 and 29), respectively. For example, if bit 6 of location 41 is a one, then it takes 16 clock cycles to start the output pulse and check the input pin, 16 microseconds is the minimum pulse width that can be measured in increments of 7 cycles beginning at 16 (16,23,30...).

Once the interface has been constructed, Program 1 can be used to test its operation. First connect pin 6 of each 555 to +5V, then load Program 1 and key in the following:

```
10 POKE 59459,15
```

```
20 FOR I=0 TO 3
30 POKE 40, 16*2 I:POKE 41,2
  I:SYS(977)
40 A = 255-PEEK (42)
  +256*(255-PEEK(43))
50 PRINT A: NEXT
```

The result should be that A is about equal to the minimum 16 in each case. The program assumes that four 555s are present with pin 2 of each connected to one of the first four pins of the user port. Pin 3 of each 555 is connected to one of the last four pins of the user port. That is, if pin 2 of a 555 is connected to PAn, then pin 3 is connected to PAn + 4. If there is a mistake in wiring or software the result will probably be a list cursor type crash.

The easiest sensor to connect in the circuit is a simple switch. If a 50K resistor is connected across the poles of the switch, the switch will present no resistance in one position and a resistance of 50K resistor is connected across the poles of the switch, the switch will present no resistance in one position and a resistance of 50L in the other position. Connecting four such switches in series with a different resistance across each one enables the 555 to determine which of the four switches has been thrown. If normally closed pushbuttons are used with resistances of 50K, 150K, 300K and 600K as buttons are pushed, a resistance of 50K when button #1 is pushed, 150K for #2, 200K for #1 and #2, and so forth. This arrangement can be used as the basis for quiz or educational games where the players give their answers by pushing one of the buttons. Since only one 555 is required for each set of switches, up to four players can play at the same time.

Another useful switch arrangement is to connect a normally open pushbutton in place of R1 for each

"DOODLE"

```
10 RT=20:UP=12
20 POKE 59459,15
30 REM CALIBRATE JOYSTICK IN CENTER
40 PRINT "[clear]PLACE JOYSTICK IN CENTER. PRE
SS ANY KEY WHEN READY."
50 GET A$: IF A$="" GOTO 50
60 POKE 40,16:POKE 41,1:SYS(977)
70 A=255-PEEK(42)+256*(255-PEEK(43))
80 POKE 40,32:POKE 41,2:SYS(977)
90 B=255-PEEK(42)+256*(255-PEEK(43))
100 AL=.6*A:AH=1.2*A
110 BL=.6*B:BH=1.2*B
```

555. If a 555 is triggered it will emit an output pulse which will continue until its pushbutton is pressed. A test of reflex speed can be constructed by triggering all four 555s, instruction the player to push one of the buttons and then measuring the time it takes him to respond.

Since the response time will be longer than the timer at 59464 can handle, the "jiffy" timer, TI, should be used. Program 2 is an example of how the timer can be used. The recheck procedure in lines 220 and 230 is needed to correct for poor pushbutton action. The value Z in line 165 should be set to yield Y^0 when there is no time delay between asking for a response and pushing the button. The same principle used in the reflex test can be used along with CB2 sound to simulate the electronic games which require the duplication of a series of sounds.

One of the more useful applications of the 555 interface is the joystick. One 555 is used to sense the position of each of the two potentiometers in the joystick. There are two ways that the joystick position can be translated into cursor movement. One is to move the cursor relative to some fixed position such as the center of the screen. In this mode a given joystick position always moves the cursor to the same spot on the screen. The technique is useful in obtaining input for games like Checkers or Othello. The other mode is to use the joystick position to indicate movement relative to the current position of the cursor. This technique is useful in maneuvering through a maze or in other real-time games. In this mode moving the joystick in a given direction moves the cursor in that direction. As long as the joystick is held in that position the cursor will continue to move. Returning the joystick to the center stops the cursor. The following sequence illustrates this technique:

Of course, this routine must be used in conjunction with Program 1. The routine can easily be expanded to move the cursor more than one location at larger joystick displacements. With some checks to keep the print position on the screen added, the program can be used to draw pictures or "doodle".

μ

John Sherburne is an operations research specialist with the Department of Defense. He has a number of years experience in mathematical computer programming. Microcomputing is his hobby.

```

1000 REM SENSE JOYSTICK POSITION
1010 POKE 40,16:POKE 41,1:SYS(977)
1020 A=255-PEEK(42)+256*(255-PEEK(43))
1030 POKE 40,32:POKE 41,2:SYS(977)
1040 B=255-PEEK(42)+256*(255-PEEK(43))
1050 REM CALCULATE NEW POSITION
1060 R=-1:IF A>AL THEN R=0:IF A>AH THEN
R=1
1070 U=-1:IF B>BL THEN U=0:IF B>BH:THEN
U=1
1080 RT=RT+R:UP=UP+U:PRINT "[home]";
1090 FOR I=1 TO UP:PRINT:NEXT
1100 PRINTTAB(RT) "X":GO TO 1000

```

PROGRAM 1

Assembly Language

03D1	A5	28		LDA	IPUT	:Load input mask
03D3	A6	29		LDX	OPUT	:Load output mask
03D5	8E	4F	E8	STX	PORT	:Set trigger high
03D8	A0	00		LDY	# 00	
03DA	84	2A		STY	ANSR	:Clear result
03DC	84	2B		STY	ANSR+1	
03DE	8C	48	E8	STY	TIML	:Clear timer
03E1	8C	49	E8	STY	TIMM	:Clear & start timer
03E4	8C	4F	E8	STY	PORT	:Bring trigger low
03E7	8E	4F	E8	STX	PORT	:Return to high
03EA	2C	4F	E8	WAIT	BIT	PORT :Wait for end of pulse
03ED	D0	FB		BNE	WAIT	
03EF	AE	48	E8	LDX	TIML	:Store result
03F2	AC	49	E8	LDY	TIMM	
03F5	86	2A		STX	ANSR	
03F7	84	2B		STY	ANSR+1	
03F9	60			RTS		

BASIC Program to Load Assembly Language

```

10 DATA 165,40,166,41,142,79,232,160,0,
132,42,132,43,140,72,232,140,73,232,140

```

```

20 DATA 79,232,142,79,232,44,79,232,208
,251,174,72,232,172,73,232,134,42,132

```

```

30 DATA 43,96

```

```

40 FOR I=977 TO 1017

```

```

50 READ A:POKE I,A:NEXT

```

PROGRAM 2

```

10 POKE 59459,15:Z=9
20 N(0)=239:N(1)=223:N(2)=191:N(3)=127
25 L$(0)="A":L$(1)="B":L$(2)="C":L$(3)="D"
30 PRINT "[clear] THIS IS A TEST OF YOUR REA
CTION TIME"
31 PRINT "[down] WHEN YOU SEE A LETTER ON THE
SCREEN"
32 PRINT "[down] PRESS THE BUTTON WITH THE SA
ME LETTER"
33 PRINT "[2 down] PRESS ANY KEY WHEN YOU ARE
READY"

```

Program 2 cont.

```

40 GET A$:IF A$="" GOTO 40
60 I=999+INT(500*RND(1))
70 FOR K=0 TO I:NEXT
120 POKE 59471,15
122 I=INT(4*RND(1))
130 TI$="000000":E=0
140 POKE 59471,0
145 PRINT "[down]";L$(I)
150 POKE 59471,15
160 WAIT 59471,255,255
170 R=PEEK(59471)
180 IF R<>N(I) GOTO 220
190 Y=INT(Y*100/60)/100
200 PRINT "YOU TOOK";Y;"SECONDS":END
220 IF E=0 THEN E=1:GOTO 170
230 IF E=1 THEN E=2:POKE 59471,0:GOTO 1
50
300 PRINT "[clear] WRONG BUTTON!":END

```

Notes:

Line 140 and line 150 start timerpulse.

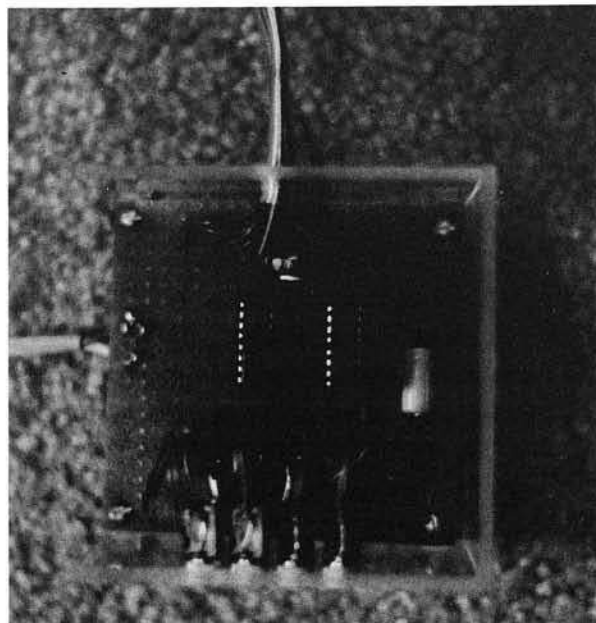
Line 160 waits until one of the pins PA4 - PA7 goes low. Line 180 checks to see if proper button was pushed. Lines 220 and 230 recheck for errors caused by poor pushbutton action.

STAR ACE

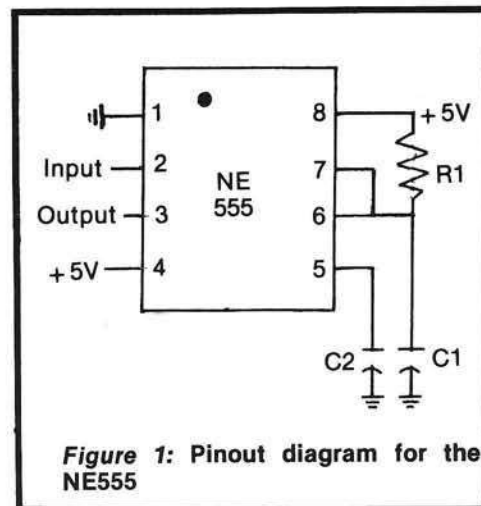
```

10 DIM DN$(24),FG$(3):POKE 59459,15
20 DATA "[down]","[2 down]","[3 down]","[4 down]","[5 down]","
"[6 down]","[7 down]","[8 down]"
30 DATA "[9 down]","[10 down]","[11 down]"
"[12 down]","[13 down]"
40 DATA "[14 down]","[15 down]"
"[16 down]"
50 DATA "[17 down]","[18 down]"
"[19 down]"
60 DATA "[20 down]","[21 down]"
"[22 down]"
70 DATA "[23 down]","[24 down]"
80 DATA "[down][back][space][down][back][space][down][back][space]
[down][back][back][back][back][back][back][back]
[up][back][space][up][back][space][down][back][back]
[back][up][back]+0"
82 DATA "[space][down][2 back][rvs][down][back][off]-[3 back][up]
[forward]"
90 FOR I=0 TO 24:READ DN$(I):NEXT
102 READ ST$:READ TG$
110 DATA "[rvs][off]****[down][4 back]****-","****-[down][5 back]
[rvs][off]","1*[down][back][down][4 back][2 space][space]
[3 back]"
112 DATA "[down][space]*[down][2 back]-[down][3 back][2 space]*[down]
[3 back]","-[space]**[down][3 back]/[down][3 back][rvs][off][2 space]
-[down][3 back]"
114 DATA "[down][space]**[down][3 back]-[space]*[down][4 back][rvs]
**[space][down][3 back][rvs][off]"
120 FOR I=0 TO 5:READ E$(I):NEXT
180 PRINT "[clear][3 space]YOUR SHIP IS UNDER ATTACK BY ENEMY"
181 PRINT "FIGHTERS. THE ENEMY FIGHTERS WILL BE"
182 PRINT "IN RANGE FOR ONLY TWO MINUTES! YOU"
183 PRINT "MUST DESTROY AS MANY AS POSSIBLE WHILE"
184 PRINT "CONSERVING LASER POWER FOR FUTURE USE"
185 PRINT "[down][3 space]USE THE JOYSTICK TO AIM YOUR LASER."
186 PRINT "[down][3 space]PRESS 'F' TO FIRE."
187 PRINT "[down][3 space]PLACE JOYSTICK IN CENTER POSITION"
188 PRINT "AND PRESS ANY KEY TO BEGIN. . GOOD LUCK!"
210 GET A$:IF A$="" GOTO 210
220 POKE 40,16:POKE 41,1:SYS(977)
230 A=255-PEEK(42)+256*(255-PEEK(43))
240 POKE 40,32:POKE 41,2:SYS(977)
250 B=255-PEEK(42)+256*(255-PEEK(43))
260 A1=.3*A:31=.3*B
261 A2=.7*A:32=.7*B
262 A3=1.3*A:33=1.3*B
263 A4=1.7*A:34=1.7*B
280 HI=0:SH=0:LM=TI
290 DY=12:RX=0:HO=20:VE=12
295 FOR I=1 TO 999:NEXT:PRINT "[clear]"
300 Y=DY+RND(1)-.5:X=RX+2*RND(1)
310 IF Y<2 THEN Y=2
312 IF Y>21 THEN Y=21
314 IF X>35 THEN PRINT "[clear]":GOTO 290

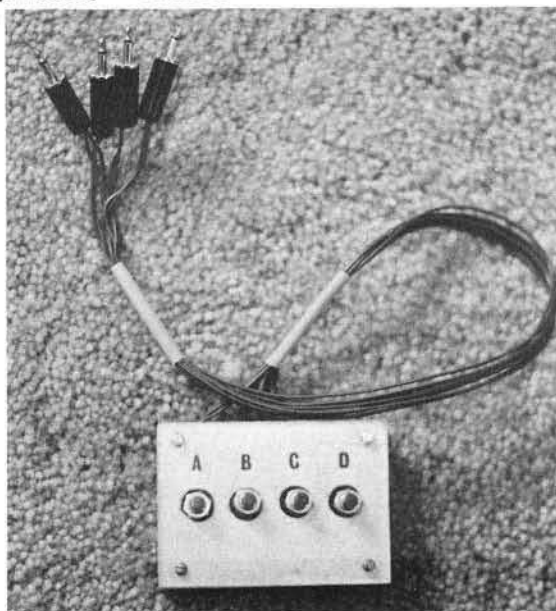
```



View of assembler four 555 interface device.



View of assembled reflex testing device.




```

400 POKE 40,16:POKE 41,1:SYS(977)
410 A=255-POKE(42)+256*(255-POKE(43))
420 POKE 40,32:POKE 41,2:SYS(977)
430 B=255-POKE(42)+256*(255-POKE(43))
440 H=2:IF A>A1 THEN H=1:IF A>A2 THEN H=0:IF A>A3 THEN
H=-1:IF A>A4 THEN H=-2
450 V=2:IF B>B1 THEN V=1:IF B>B2 THEN V=0:IF B>B3 THEN
V=-1:IF B>B4 THEN V=-2
460 H=H+H:V=V+V
461 IF V>19 THEN V=19
462 IF H>35 THEN H=35
464 IF H<0 THEN H=0
466 IF V<0 THEN V=0
520 PRINT "[clear]";DN$(V)TAB(H)ST$
530 PRINT "[home]";DN$(Y)TAB(X)TG$
535 IF TI-LM>7200 GOTO 700
540 HO=H:VE=V:DY=Y:RX=X

```

STAR ACE requires use of a joystick and the assembly language interface programs. Brackets, [], are used to show special characters. For example, [3down] means three down cursor characters.

```

550 GET A$:IF A$<>"F" GOTO 300
555 PRINT "[home]";"LASER'S FIRED!";SH=SH+1
556 C=PEEK(32580+40*V+H)
560 IF C<98 AND C<254 GOTO 300
565 PRINT "[clear]";DN$(Y)TAB(X)E$(0)
570 PRINT "[clear]";DN$(Y)TAB(X)E$(1)
575 FOR I=1 TO 4
580 FOR J=2 TO 5
590 PRINT "[clear]";DN$(Y+I)TAB(X)E$(J)
595 NEXT J:NEXT I
600 HI=HI+1:PRINT "[clear]HITS ";HI:PRINT "SHOTS FIRED ";SH
610 GOTO 290
700 SC=100*HI-(10*SH)
710 PRINT "YOUR SCORE IS ";SC
720 IF SC>499 THEN PRINT "[3 down]ACE!!!! CONGRATULATIONS.";
END
730 IF SC>249 THEN PRINT "[3 down]GOOD SHOOTING!";END
740 IF SC>0 THEN PRINT "[3 down]YOU NEED MORE PRACTICE";END
750 IF SC<1 THEN PRINT "[3 down]YOU'RE LUCKY TO STILL BE
ALIVE";END

```

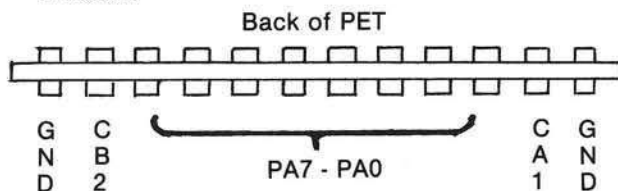


Figure 2: Rear view of the PET Parallel User Port. All pins are on the bottom of the edge card. PA0 is to the right.

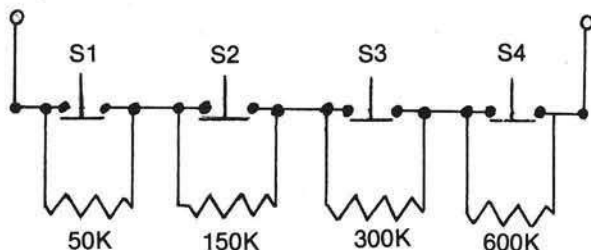
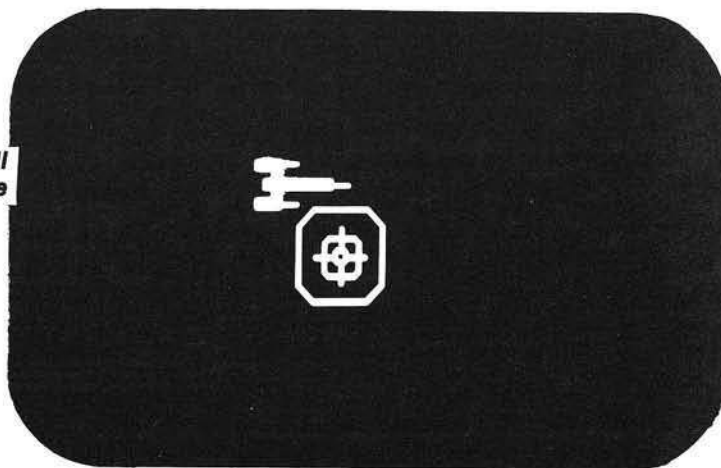


Figure 4: Schematic of a response sensing device.



Screen display from STAR ACE game.

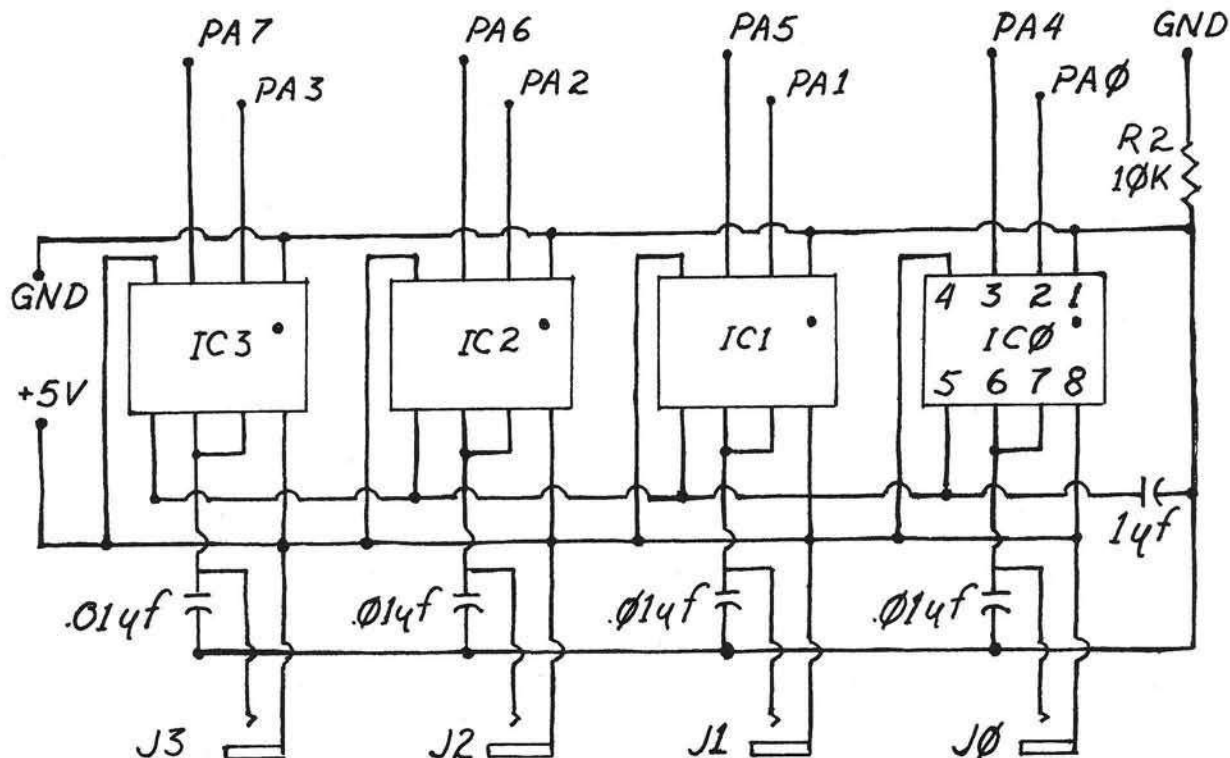
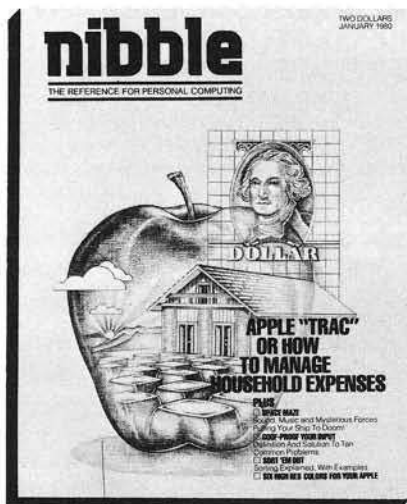


Figure 3: Schematic of a four device interface. Connections to the computer are at the top. Jacks J0 to J3 are phone jacks for connecting sensors. All capacitors are Mylar.

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Zoom And Squeeze

A short program for the Apple II which makes it easier to edit BASIC programs. ZOOM provides a fast way to copy over a program line; SQUEEZE changes the screen width to 33 characters and eliminates embedded blanks.

Gary B. Little

ZOOM and SQUEEZE is a short machine-language routine written for the APPLE microcomputer in order to facilitate the editing of BASIC programs. It recognizes two commands: CTRL-Q and CTRL-Z. The CTRL-Q command causes the screen window width to be automatically set to 33 and the CTRL-Z command causes the cursor to quickly copy over all text from its current position to the end of the line.

The ZOOM Feature

In order to edit a program line on the APPLE it is necessary to more than simply move the cursor directly to the area to be changed, make the changes, and then press RETURN—the required procedure is to position the cursor at the beginning of the line number, copy down to the area to be changed (by using the right-arrow and repeat keys, make the changes, and enter the edited line. If the line is a very long one, the copying-over part of this procedure takes up an enormous amount of time which can be better used for other purposes.

The 'ZOOM' part of the ZOOM and SQUEEZE routine can be used to speed up this copying tremendously. By simply pressing CTRL-Z the

cursor can be moved virtually instantaneously from its current position to the right edge of the current line while automatically copying over all the text on the screen in between. For example, to copy over a program line that takes up three lines on the video screen takes only six quick steps after the cursor has been positioned at the beginning of the line number: CTRL-Z, right-arrow, CTRL-Z, right-arrow, CTRL-Z, RETURN. This takes approximately 2 seconds to accomplish. By way of contrast, to copy over the line in the ordinary way by using the right-arrow key in conjunction with the repeat key takes approximately 13 seconds (see the NOTE below!)

It is clear, then, that this feature could save hours of debugging time for a busy programmer.

The SQUEEZE Feature

When a line of a BASIC program is listed on the video screen with the window width set at its default value of 40 columns, the output is carefully formatted by the APPLE by embedding blanks on the left and right sided of the listing. That is to say, there is not a continuous 'wrap-around' display of the information that you typed in to create the line. For example, if you enter the line

```
100 PRINT "THIS IN AN EXAMPLE  
OF A FORMATTED LISTING"
```

and then LIST it, the APPLE will respond with

```
100 PRINT "THIS IS AN EXAMPLE  
OF A F**  
****ORMATTED LISTING"
```

where a '**' indicates an embedded blank. This formatting technique makes it very easy to read a LISTed line, but it can create a minor problem when it becomes necessary to edit the line.

The problem arises when, as in the example, the blanks are embedded between the quotation marks associated with a PRINT statement. If this line is to be edited without retyping it from scratch, the right-arrow key (in conjunction with the repeat key) must be used to copy over substantial portions of the line and by so doing all 6 of the embedded blanks between 'F' and 'ORMATTED' will mysteriously appear in the argument of the PRINT statement UNLESS they are skipped over by performing pure-cursor movements — i.e., repeated ESC-A commands or, for AUTOSTART ROM users, repeated K commands after ESC has been pressed. The need to perform these pure-cursor movements is annoying and inconvenient to say the least.


```

2 *****
3 *
4 * ZOOM AND SQUEEZE PROGRAM *
5 * BY GARY LITTLE *
6 * #101-2044 W. 3RD AVE. *
7 * VANCOUVER, B.C. *
8 * CANADA V6J 1L5 *
9 * JANUARY 1980 *
10 *
11 * ENTER '300G3DOG' TO ACTIVATE *
12 * (OR BRUN FROM DISK). *
13 *
14 * ENTER CTRL-Z TO ZOOM THE *
15 * CURSOR TO THE RIGHT-MOST *
16 * POSITION OF THE LINE (TEXT IS *
17 * AUTOMATICALLY COPIED OVER). *
18 *
19 * ENTER CTRL-Q TO SQUEEZE THE *
20 * COLUMN WIDTH TO 33. *
21 *
22 *****
23 WIDTH EQU $21 WINDOW WIDTH
24 CH EQU $24 HORIZONTAL CURSOR POSITION
25 BASL EQU $28 SCREEN BASE ADDRESS POINTER
26 KSWL EQU $38 INPUT HOOK (LO)
27 IN EQU $200 INPUT BUFFER
28 KEYIN EQU $FD18 KEYPRESS ROUTINE
29 ORG $300
30 LDA #<INHK SET INPUT HOOK
31 STA KSWL TO SINHK
32 LDA #>INHK
33 STA KSWL+1
34 RTS
35 INHK JSR KEYIN GET A CHARACTER
36 CMP #S91 CTRL-Q PRESSED?
37 BNE CTRLZ IF NOT, CHECK FOR CTRL-Z
38 LDA #S21 CHANGE WINDOW WIDTH
39 STA WIDTH TO 33
40 LDA #S40 OUTPUT A SPACE
41 RTS
42 CTRLZ CMP #S0A CTRL-Z PRESSED?
43 BNE RTS1 IF NOT, RETURN
44 LDY CH TAKE A CHARACTER
45 LDA (BASL),Y OFF VIDEO SCREEN
46 PHA
47 INC CH
48 INC CH
49 LDA CH IF CURSOR POSITION IS
50 CMP WIDTH AT FAR RIGHT,
51 BCS FIN THEN FINISHED
52 DEC CH
53 PLA ;STORE CHARACTER
54 STA IN,X IN INPUT BUFFER
55 INX
56 BNE LOOP GET ANOTHER CHARACTER OFF SCREEN
57 DEX ;BUFFER FULL,
58 RTS ; SO RETURN
59 FIN PLA
60 DEC CH SET PROPER CHARACTER
61 DEC CH POSITION AND
62 RTS1 RTS ; RETURN

```

This problem can be avoided if the window width is 'squeezed' to 33 columns before LISTing the line and editing it. If this is done, the embedded blanks disappear and the line can be edited without worrying about the need to perform pure-cursor movements.

The window width can be changed to 33 by entering the command POKE 33,33 from BASIC immediate-execution mode. However, with the ZOOM and SQUEEZE routine in effect all that need be done is to press CTRL-Q. The width can be returned

to its default value of 40 by simply entering the command TEXT from immediate-execution mode.

How ZOOM AND SQUEEZE Works

ZOOM and SQUEEZE can be activated by BRUNning it from disk or by loading it, entering the command 300G from the monitor, and then returning to BASIC. The routine resides from \$300 to \$33A.

After it has been activated, the APPLE's input hook at \$38 (low), \$39 (high) is set equal to the ZOOM and

SQUEEZE entry point at \$309. Thereafter, all keyboard input is checked to see whether CTRL-Q or CTRL-Z has been pressed; if not, then nothing special happens.

If CTRL-Q is pressed, the short subroutine beginning at \$310 and ending at \$316 is executed. All this subroutine does is store \$21 (decimal 33) at location \$21 — this is the location in the monitor that contains the current window width. A blank is then displayed on the screen to indicate that this has occurred.

If CTRL-Z is pressed, the subroutine beginning at \$317 is executed. What happens then is that the characters displayed on the screen from the current cursor position to the end of the line are placed in the input buffer one-by-one. If the buffer is overflowed, the program line will be backslashed and cancelled in the ordinary way.

Details of the programming algorithms involved can be easily deduced by inspecting the accompanying source listing for ZOOM and SQUEEZE.

NOTE: it is possible to speed up the repeat-key function by soldering a 100K resistor in parallel to the resistor at position R4 on the APPLE keyboard unit. For details, see the article 'REPEAT KEY SPEED-UP' by V.R. Little in the February 1980 edition of APPLEGRAM, the newsletter of the Apples British Columbia Computer Society, Vancouver, B.C.

μ

Gary B. Little first became interested in computers by writing data analysis programs in FORTRAN on an IBM 370/168 for an M. SC. degree in Physical Chemistry (Microwave Spectroscopy). Ultimately he became interested in microcomputing and purchased an APPLE II micro 1½ years ago.

He was past president of APPLES BRITISH COLUMBIA COMPUTER SOCIETY, an an APPLE user group located in Vancouver, B.C. Gary is currently the treasurer of this group.

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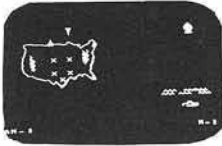
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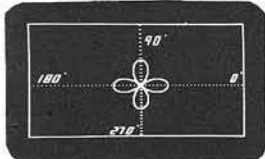
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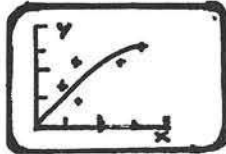


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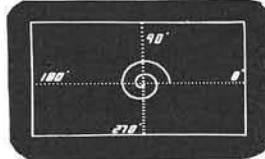


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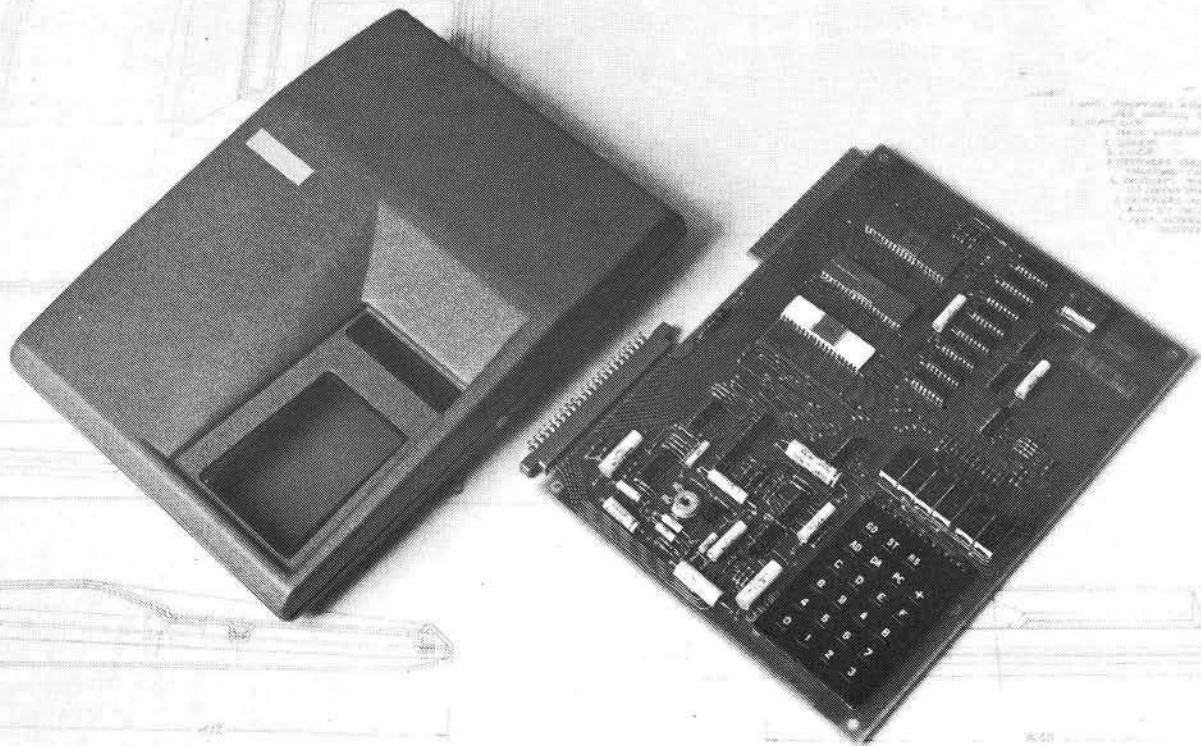
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OHIO SCIENTIFIC'S

Welcome to the second issue of the Ohio Scientific Small Systems Journal in Micro.

In this issue, Ohio Scientific is pleased to introduce a new concept in computer interfacing — the Sixteen Pin I/O BUS. The BUS concept as well as several boards and applications are covered in the following pages.

Also in this issue, a short, graphics oriented game in BASIC called 'FOO' is presented.

Reader suggestions on article content are welcome. Please submit them to:

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Aurora, Ohio 44202

The Ohio Scientific Sixteen Pin I/O BUS

Ohio Scientific is pleased to introduce a unique new product line — The 16 Pin I/O BUS. With this system it is possible to add up to eight special function boards while occupying only one backplane slot.

This is made possible by a novel BUS extension method which allows decoding, timing and eight bits of data to be carried on standard, inexpensive 16 pin ribbon cables.

Up to eight inexpensive 16 pin cables with standard DIP connectors may be attached to a single CA-20 board which in turn occupies one slot of the standard Challenger backplane. Alternately, one 16 pin I/O BUS cable may be attached to the CA-15 board at the rear of all C4P and C8P products. Note, in the case of the C4P-MF this allows system expansion beyond the normal four slot backplane.

Currently, five HEAD END CARDS are available for interconnection to the system via the CA-20 or CA-15 boards.

Computer Interface to Sixteen Pin I/O BUS

The 16 pin I/O BUS may be attached to your computer via two different boards — the CA-15 or the CA-20. The descriptions of these boards are as follows:

CA-15 Board

The CA-15 board is a standard accessory interface installed on the following Ohio Scientific systems: C4P-MF, C4P-DMF, and C8P-DF.

The CA-15 is mounted at the rear of the computer and contains the following interface connections:

Joystick and numeric keypad
Modem and serial printer
Sixteen PIA lines (normally used for the Home Security system — AC-17P)
Sixteen Pin I/O BUS

The interconnect for the Sixteen Pin I/O BUS is simply a 16 pin DIP socket. To use the BUS, all that you have to do is attach one end of the 16 pin ribbon cable to the CA-15 board and the other end of the cable to one of the HEAD END CARDS.

Please note that some of the HEAD END CARDS require more power than may be practically carried via the ribbon cable alone. Therefore, some of the cards require auxiliary power supplies.

CA-20 Board

The CA-20 board contains all the necessary logic to decode eight distinct HEAD END CARD interfaces. The actual interconnect, as with the CA-15, is via simple 16 pin DIP sockets and standard 16 pin ribbon cables.

The CA-20 board also requires one slot of your computer's backplane. But remember, from this one slot you gain access to a maximum of eight accessory boards.

The CA-20 is recommended for use in the Ohio Scientific C2 series and C3 series computers. It can also be installed in C4P and C8P series systems with some modification to the CA-15 interface.

Since the logic required for the I/O BUS interface is pretty simple, an additional feature was added to the CA-20 board — a crystal controlled 'time-of-day' clock (hardware) subsystem. The operation of the clock, excepting reading time and setting time, is totally independent of the host computer. As a matter of fact, with the included on-board, auto-recharging, battery back-up, your computer may actually be turned off for several months without losing time.

The features of the clock subsystem are as follows:

Hours, minutes, seconds and 1/10 seconds
Day of week
Day of month
Month of year
Four Year calendar

If you happen to own (or use) a C2 series or C3 series computer, the CA-20 board can actually control the power cycling of the entire computer when equipped with an optional power sequencer package. This means you can preset a time (month, day, hour, etc.) within the clock subsystem and that preset time agrees with the actual time. A.C. power is applied to the entire computer system through the power sequencer. At a later time, the system's A.C. power may also be removed and the system shut down under software/clock subsystem control.

For applications where the clock subsystem is not required, the CA-20A will perform all the Sixteen Pin I/O BUS functions associated with full-feature CA-20.

HEAD END CARDS

HEAD END CARDS is a general name used to describe any or all of the special function boards which attach to the Ohio Scientific Sixteen Pin I/O BUS. There are currently five such boards and, with the exception of the CA-22, they will only interface with the computer via the Sixteen Pin I/O BUS.

Please note, as detailed earlier, you must use a CA-15 or a CA-20 board at the 'computer end' of the Sixteen Pin I/O BUS to complete the interface.

In the following pages, a brief product and application

SMALL SYSTEMS JOURNAL

description of the currently available HEAD END CARDS will be presented.

Bit Switching and Sensing — The CA-21

The CA-21 is a 48 line parallel I/O board featuring three 6821 PIAs (peripheral interface adapters) and prototyping/interconnect areas.

The use of PIAs in the design allows for maximum interface versatility as you may configure any one of the 48 I/O lines as either an input or an output. As outputs, each line is capable of driving a minimum of one standard TTL load.

Additional versatility is added because 24 of the lines, when configured as outputs, may simultaneously function as inputs. This feature, although somewhat confusing, is extremely useful for applications such as switch matrix decoding.

Each of the 48 lines is brought out to two foil pads (suitable for wire wrap stakes) as well as a location on one of four 12 pin Molex-type female edge connectors. There are also eight 16 pin DIP socket locations which are intended for use as prototyping areas. Additionally, the 12 PIA 'hand-shaking' lines are brought to 12 single foil pads.

The CA-21, with proper buffering, may be used for virtually any computer controlled bit switching or bit sensing application that you can imagine. With a full complement of eight CA-21s interfaced via the CA-20, a total of 384 individually controllable I/O lines are possible!

An interesting application using one CA-21 board would be a complete, is somewhat slow, emulation of the standard Ohio Scientific BUS.

A more standard application might be augmenting the standard Home Security System (AC-17P) with 'hard-wired' sensors.

One type of sensor you could easily add is a standard window 'perimeter detector'. This could be done with commercially available adhesive foil tape. You could then detect a break-in (through a broken window) by sensing a break in the foil tape.

Another useful application you could set up in concert with the AC-12P wireless A.C. Remote Control, might be sensing when a room is entered. You could accomplish this with pressure-switch door mats or door switches. When room entry is detected, the lights could be turned on or, turned off on exit.

If you are designing any sort of dedicated control system, the CA-21 is an ideal choice. You can easily sense innumerable types of input (pressure transducers, flow sensors, switches, etc.) while controlling outputs from a simple single LED display to a network of solid state relays controlling A.C. power.

EPROM Programmer — The CA-23

The CA-23 is an EPROM programmer designed for use with the growing families of 5 volt only EPROMS. With the CA-23 you can program and verify all 1K through 8K byte EPROMS of this type. Note these parts are often identified

as 8K — 64K bit EPROMS.

The CA-23 can program (or verify) data in two basic modes — EPROM to/from EPROM or EPROM to/from computer RAM memory. Additionally, EPROM data may be read directly into the computer's RAM memory.

There are four LED indicators on the CA-23. The first is 'SOCKET UNSAFE'. This means that a programming voltage is present at the socket and if you insert or remove an EPROM it is likely to be damaged.

The second indicator is 'PROGRAMMING'. This means that your EPROM is currently being programmed.

The third indicator is 'ERROR'. This means that somewhere along the line your programming attempt was unsuccessful.

The final indicator is 'PROGRAM COMPLETE'. This means that your program and verification was successful.

The most intriguing application for this product is the creation of 'custom' parts for your computer or peripherals. This could range from a new system monitor to a new high level language. It could even include a new character generator for your CRT or printer. Note, however, tinkering around with the internals of computers and peripherals requires a fairly high degree of technical expertise. Also, most manufacturer's warranties are voided by these types of modifications.

Several OEM (original equipment manufacture) and Research/Development applications will be immediately obvious to those you involved in that work.

The CA-23, as previously mentioned, is designed for use with 1K through 8K byte EPROMS. These parts come in various package styles and have various product names. For example, Intel's 2Kx8 part is the 2716, Texas Instruments' part is known as the 2516.

The CA-23 has both 24 pin and 28 pin zero insertion force sockets for reading, programming and verifying the EPROMS.

Prototyping — The CA-24

The CA-24 is a solderless bread-board designed for proto-typing, experimental and educational applications.

The bread-boarding is made up of seven solderless plug-strips of the type manufactured by AP Products. Two of the plug-strips contain a connection matrix of 5 by 54, connections and are used as signal distribution points. Another pair of 96 location plug-strips are for powering the bread-board area. The actual experimenter area is comprised of three plug-strips, each with a 10 by 64 location connection matrix. Additionally, sixteen LED indicators and sixteen DIP switch positions are provided for signal observation and control functions.

Board I/O is via TTL latches and bi-directional PIA ports as well as direct (buffered) data, signal and control lines from the computer BUS. This method allows you to directly interconnect devices such as 6850 ACIAs in addition to doing more 'isolated' and/or independent circuits.

OHIO SCIENTIFIC'S

The CA-24 also contains a 'clock' generator which is continuously variable from approximately 25,000 Hz. through 70,000 Hz. You may also connect the clock to an on-board 16 stage divider chain. This allows division of the fundamental frequency by as little as 2^1 (2) to as much as 2^{16} (65,536).

The applications for the CA-24 are primarily prototyping and experimenting. Parts may be inserted and removed from the terminal strip blocks over and over. Interconnection of parts is accomplished simply with solid, narrow gauge wire jumpers. Errors in design or connection are extremely easy to correct.

The CA-24 lends itself very well to structured experiments that are common in the educational environment. It is an ideal tool to aid in the teaching of computer and computer interface fundamentals.

Accessory Interface — The CA-25

The CA-25 is designed to implement some of the functions normally associated with the CA-15 interface board.

It allows you to directly connect the Home Security System (AC-17P) and/or the Wireless A.C. Remote Control System (AC-12P) to C2 and C3 series computers. Additionally, if you own an older Ohio Scientific computer, you can now easily connect these systems to it.

An extremely useful application of the CA-25 is associated with small business systems. Using the CA-25 with the Home Security System, and perhaps a CA-15V (Universal Telephone Interface with speech synthesizer output), the computer could do payroll, inventory, etc. by day and 'guard' the shop by night.

Analog I/O — The CA-22

The CA-22 is a high speed analog I/O module. Although the CA-22 is classified as a HEAD END CARD, it differs from the rest of the family in that it may also be plugged directly into the computer's standard internal BUS. This allows for maximum flexibility in the use of the CA-22.

The analog input section of the CA-22 consists of a 16 channel analog multiplexer. This means that you may connect up to 16 separate signals directly to the CA-22. Also included is a sample and hold circuit followed by the analog to digital converter circuitry.

The A to D converter is capable of either 8 bit or 12 bit operation. You may select these options under software control.

The accuracy of the converter is plus or minus one in the least significant bit. The stability of the circuit is rated at one millivolt drift per degree Centigrade.

The A to D conversion is extremely fast. It is capable of digitizing up to 66,000 samples per second in the 8 bit conversion mode and 28,000 samples per second in the 12 bit mode. Shannon Sampling Theory states that signals should be sampled at twice their frequency. Therefore, it is possible for you to convert signals with a frequency greater than 30K Hz. Clearly, high fidelity audio is well within the spectrum of the CA-22.

The multiplexer has very high impedance inputs and is capable of accepting inputs in the range of -10 volts through +10 volts. The input is jumper selectable for other settings including a single sided range of 0 through +10 volts.

Due to the indeterminable nature of the actual inputs that you may actually apply to the CA-22, only the multiplexer inputs are brought out. However, a quad op-amp is laid out in foil which you may populate in several different modes to handle some of the more 'common' input configurations.

The analog output section of the CA-22 consists of two identical high speed digital to analog converters. Each DAC can convert either 8 bits or 12 bits of data. Data input to the DACs is latched in such a manner that, when in the 8 bit conversion mode, the other four (of the total of twelve) bits are continuously output at a predefined value. You may, of course, define that value under software control.

The output of each DAC is buffered with a high speed op-amp capable of changing 20 volts every microsecond. The standard configuration of each output is bi-polar with a voltage swing of -10 volts through +10 volts. This is jumper selectable to allow a uni-polar output of 0 through +10 volts.

Some additional I/O capacity is provided on the CA-22. There are three TTL level inputs and six open collector logic outputs. These are strappable to be either standard TTL level outputs or high-voltage outputs.

You can use the CA-22 for a multitude of analog sensing and/or analog controlling applications.

Using the proper transducers and the 16 input channels, you can monitor the temperature in several zones of a home or office. By extending this system with a CA-21, you could maintain precise temperatures by switching the proper controls on and off.

Another interesting, if somewhat obvious application, is in audio processing. Reverberation, phase shifting and echoing are just a few of the uses you could implement.

If you used blocks of RAM for data storage, other applications such as frequency doubling, etc., could be experimented with.

If you apply more sophisticated software techniques, such as a fast Fourier transform, on stored input data, very elaborate signal processing becomes realizable. Projects such as audio spectrum analyzers and speech recognition experiments are certainly practical. Note, in these types of applications you are likely to find some signal pre-processing in hardware is certainly beneficial - if not totally necessary.

If you employ both DAC outputs and the on-board unblanking circuit, X-Y oscilloscope plotting is an interesting application. By using these techniques and one or more of the analog inputs, you can construct a digital storage scope. Note, both of these applications require that you have access to an oscilloscope capable of X-Y input as well as blanking.

SMALL SYSTEMS JOURNAL

Summary

With the introduction of the 16 pin I/O BUS, Ohio Scientific has opened a new world on interfacing capabilities for both the large and the small computer user.

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For pricing and availability, contact your nearest Ohio Scientific dealer.

FOO

This is an amusing graphics game that simulates a twisting road scrolling up from the bottom of the screen. You must avoid going off the road. Speed and road width are selectable. Pedestrians are also optional, with a bizarre twist. At your option pedestrians are to be avoided or run down for points. FOO runs on disk based C4P and C8P video systems. The tone generator is used to provide sound. The program is easily adapted to OSI BASIC-in-ROM computers.

```

100 POKE 2893,55:POKE2894,8:POKE2073,96
110 BS=55040:SM=2:MS=1:KY=57088:ME=54144+15:MI=0:RN=0
115 ML%=0
117 SN=255
120 LP=5
130 PL=2/LP
135 POKE57089,1
140 POKE9680,32:POKE56832,2
150 C=226
155 KP=0
160 IFA$='Y'THENME=EM:WI=WF:GU=UG:GOTO270
170 FORI=1TO30:PRINT:NEXTI
180 PRINT'F O O'
190 PRINT:PRINT' R A C E W A Y'
200 PRINT:PRINT'You run at your own risk!'
210 PRINT:PRINT'<== LEFT=1 RIGHT=2 ==>'
215 PRINT:PRINT'OVERDRIVE=RUBOUT'
220 PRINT:PRINT'SUGGEST WIDTH=20, DELAY=20'
230 PRINT:INPUT'INITIAL WIDTH (0-30)':WI
240 PRINT:INPUT'DELAY (1-20)':ME:EM=ME
245 PRINT
250 GU=0:INPUT'PEDESTRIANS
(Y/N)':X$:IFLEFT$(X$,1)='Y'THENGU=.3
255 UG=GU:PRINT
257 IFGU=0THEN270
260 KP=0:INPUT'KILLER FOO
(Y/N)':X$:IFLEFT$(X$,1)='Y'THENPK=1
270 PRINT:PRINT'Hidden wonders await
the':PRINT'Masters!'
280 FORI=1TO30:PRINT:NEXTI
290 WD=WI:WF=WI:ME=55104+15-ME*64:WT=(30-WI)/2
295 IFA$='Y'THENRETURN
300 FORM=1TOLP:GOSUB600:GOSUB500:ML%=ML%+1:NEXTM
350 WI=WI-1
360 LP=LP*1.14
370 IFWI>4THEN300
380 SM=SM+.2:MS=MS+.1
400 FORM=1TOLP:GOSUB600:GOSUB500:ML%=ML%+1:NEXTM
450 WI=WI+1
460 LP=LP*.85
470 IFWI<WDTHEN400

```

```

475 IFWD<2THENWD=WF
480 WD=WD*.75
490 GOTO300
499 REM OUTPUT A FRAME
500 RN=RN+SM*RND(1)-MS
510 WT=WT+SGN(RN)
520 IFWT+WI>28THENWT=WT-1:RN=0:GOTO520
530 IFWT<0THENWT=0:RN=0
540 IFWI>8ANDRND(1)<GUTHENPOKEBS+WT+1+INT
(WI*RND(1)),240
550 PRINTSPC(WT);'><';SPC(WI);'><'
560 RETURN
599 REM MOVE BALL
600 POKEY,128:K=PEEK(KY):KK=0:POKEY,64:K2=PEEK(KY)
610 IFKAND128THENME=ME-1:KK=-1+0*RND(1)
620 IFKAND64THENME=ME+1:KK=1
630 IFK2AND4THENME=ME+KK
640 IFPEEK(ME)<>32THEN700
650 POKEME,C
660 RETURN
700 GY=PEEK(ME):IFGY=240ANDPKTHENKP=
KP+1:GOSUB2000:GOTO650
710 POKE 2073,173
715 FORI=100TO250STEP5:POKE57089,I:NEXTI
719 POKE57089,1
720 PRINT'YOU BLEW IT!!!'
725 PRINT
730 MI=ML%*PL
750 PRINT'AFter 'MI;'MILES'
755 IFPKTHENPRINT'AND 'KP;'KILLS'
757 PRINT:PRINT'TOTAL
POINTS:':INT(MI+4*(1-PK)*MI+100*KP)
760 GOSUB1000
770 K=1
780 FORI=1TO1000*K:NEXTI
790 IFPEEK(KY)<>1THEN790
800 POKE9680,95
805 POKE57089,1
810 GOTO5000
1000 IFPKTHENWD=KP:GOTO1030
1010 WD=MI/WF
1030 PRINT:PRINT'Congratulations!'
1040 PRINT'You may now call yourself'
1050 PRINT:PRINT'
';
1060 IFWD<3THENPRINT'LITTLE';:GOTO1200
1070 IFWD<5THENPRINT'TENDER';:GOTO1200
1080 IFWD<12.5THENPRINT'MEDIOCRE';:GOTO1200
1090 IFWD<25THENPRINT'BIG';:GOTO1200
1100 IFWD<38THENPRINT'MASTER';:GOTO1200
1110 IFWD<50THENPRINT'GRAND';:GOTO1200
1120 PRINT'CHEATER';
1200 PRINT'FOO';
1210 IFGY=240THENPRINT'KILLER';
1220 PRINT''
1230 RETURN
2000 SN=SN-5
2003 IFSN=50THENSN=255
2005 POKE57089,SN
2010 POKE 57089,1
2020 RETURN
5000 INPUT'AGAIN':A$:A$=LEFT$(A$,1)
5010 IFA$<>'Y'THEN6000
5020 INPUT'SAME':A$:A$=LEFT$(A$,1)
5025 IFA$<>'Y'THENCLEAR
5030 GOTO100
6000 END

```

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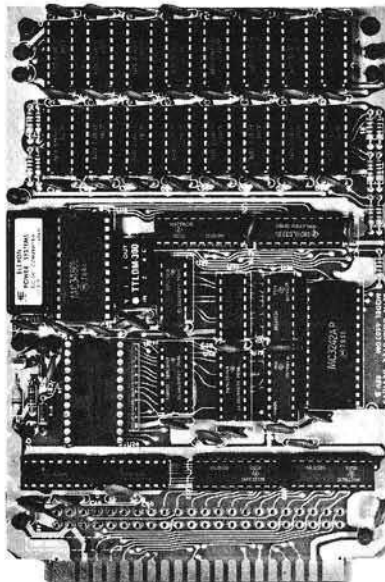
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VIZA — KIM

A KIM Monitor extension program which provides the automatic display of the important system parameters at each step. The discussion reveals some details of the 6502 interrupt handling mechanism.

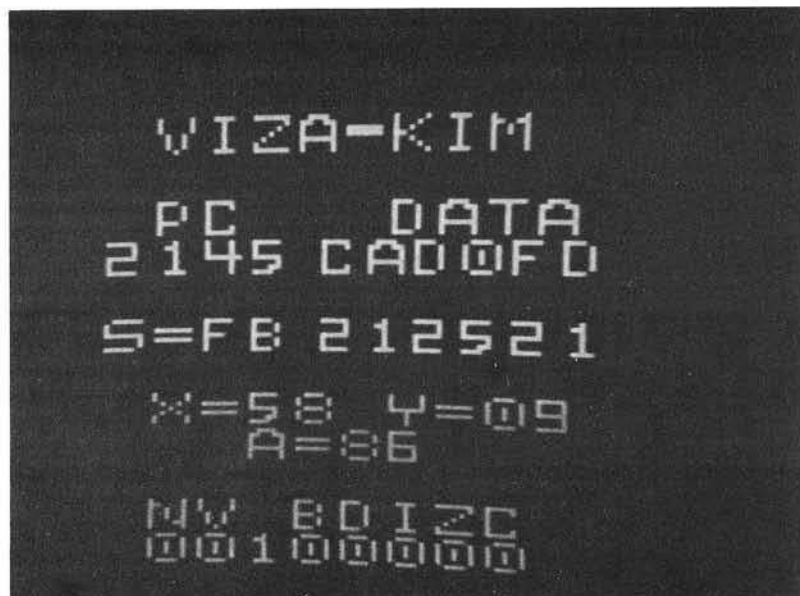
Joel Swank

After reading George Lang's article on his U-PANEL project (MICRO-COMPUTING, January 1979), I decided to implement his idea on my KIM-1 system. U-PANEL is a front panel display for KIM. It uses an extension of the KIM single step circuit (SST) and a small routine to dump the processor registers in binary to a panel of discrete LEDs. This is done by connecting the KIM SST signal on pin E-17 to the IRQ interrupt line on pin E-44. The SST signal is generated every time the CPU SYNC signal is generated and the instruction being executed is not located in the KIM ROM. SYNC is generated with each opcode fetch. Normally during KIM single step operation the SST signal is switched to the nonmaskable interrupt (NMI) line. This causes an interrupt during the first cycle of each instruction. Since an instruction cannot be interrupted in the middle, the interrupt is recognized immediately after the instruction is finished. The NMI vector cannot be set to a routine outside the KIM ROM while the SST switch is on because the first instruction of that routine will also cause the NMI interrupt to be taken, resulting in a continuous loop. Instead of the NMI George switched the SST signal to the IRQ line, KIM's maskable interrupt. This allows the interrupt to be vectored to any routine anywhere in the system rather than just the KIM ROM. The IRQ vector was changed to the register dump routine which returns control to KIM after outputting the registers to U-PANEL. This routine must run with interrupts disabled to prevent it from being interrupted.

Since I don't particularly care for reading binary lights, I decided to dump in HEX to my CRT terminal. This saves building the U-PANEL and provides a more readable display. The changes to George's program were simple and I soon had my code ready to test, but I couldn't get it to work properly. I double checked everything and it all looked OK. So I started to analyze the problem.

The register dump to the CRT was working, but the CPU was not being interrupted after each instruction. It would execute a few instructions and then stop. When I pushed GO it would execute a few more and stop. After a little thought I decided to see which instructions were being executed without being interrupted.

Soon a pattern emerged. The CPU was being interrupted only after instructions whose execution time were two cycles. Any instruction whose execution time was 3 or more cycles was not being interrupted. Why? The answer lies in the MOS Technology hardware manual. The NMI interrupt is edge sensitive. That is, the interrupt is recognized by the change from high to low not just the presence of the low signal. Also, once the transition has occurred the processor will be interrupted before the next instruction starts, no matter what. The IRQ is not edge sensitive. A low on the IRQ line must coincide with a zero in the processor interrupt flag and the last cycle of an instruction. If the IRQ line goes low and high again while the CPU is not ready to accept inter-



rupts, the interrupt will be missed. In this case the SST signal because it is driven by SYNC will be low during the first cycle of an instruction and because of propagation delay, slightly into the second cycle. Therefore any instruction that is 3 cycles or longer will cause the interrupt to be missed. So the interrupt occurs only after two cycle instructions (the 6502 has no one cycle instructions).

To fix this problem the SST pulse must be lengthened to last at least as long as the 6502's longest instruction. The circuit in figure one does this. It uses a one shot to extend the pulse. This circuit produces a pulse of about one millisecond, much longer than needed, but it doesn't matter as long as the pulse is long enough. This circuit will provide a properly operating U-PANEL.

After resolving the pulse length problem I decided to add a slow motion feature. This would be a mode that would execute an instruction and then, after dumping the registers, instead of returning to KIM, would delay for a programmable amount of time and execute the next instruction. This would allow the execution of a program in slow motion without pushing GO between each instruction. The code needed to add this feature is fairly simple and it was soon ready to test. I implemented it with a time value at \$E9. This value is the delay time in quarter seconds. Zero means slow motion not in effect. On first try I set the delay to two seconds and started the program. The first instruction was executed and the registers dumped, but there progress stopped. The delay was working properly and the display being updated every two seconds but the PC was not advancing. It was stuck on the second instruction. I stopped execution and started it again. This time the second instruction was executed and it stuck on the third. Once again the problem was in the non edge sensitive IRQ interrupt.

When in normal mode, each instruction in the dump routine generates a pulse. These pulses are ignored during execution of the dump routine because it runs disabled. The pulses stop once execution enters the KIM ROM. The RTI instruction that KIM executes as a result of pushing GO enables the IRQ and the first instruction in the

object program generates a pulse that causes an interrupt immediately after it executes. The dump routine is then executed, and control is returned to KIM to wait for the next GO. In slow motion mode the GO routine is executed via a JMP instruction from the dump routine. If the pulse generated is longer than the time needed to execute the GO routine (about 38 microseconds) the IRQ line will still be low from the JMP instruction when the RTI instruction is executed. This will cause an interrupt immediately after the RTI instruction and no instruction of the object program will be executed. To solve this problem, the pulse must be shortened to less than the duration of the GO routine. This can be done by changing the resistor in figure one to 2K Ohms. This generates about a 35 microsecond pulse, longer than the longest 6502 instruction but shorter than the KIM GO routine.

I called my version of the program VIZA-KIM. The code for version 1 is included. It provides a formatted display on the CRT after each instruction is executed. Version 2 has been enhanced to display in large characters on my SWTPC GT-6144 graphics board. This display on my 19 inch TV can be read by an entire room of people. VIZA-KIM makes an excellent device for learning the operation of the CPU. The exact effect of each instruction can be seen.

The VIZA-KIM dump displays the program counter (PC) and the first three bytes of data at that location. A nice enhancement would be to include a line for a disassembled instruction. The next line is for the stack pointer (SP). The current stack pointer is displayed along with three bytes from the stack page. The first byte is where the next push operation will store its data. The 6502 stack pointer always points to the next available byte. The next two bytes are the data from the last two push operations, or the data that will be read by the next two pull operations. If the last push operation was a jump subroutine (JSR) instruction this will be the return address minus 1. Next are the index registers (X and Y) and the accumulator (A). Last is the processor status register (P). All data is displayed in HEX except for P. P is formatted in binary since its in-

dividual bits have separate meanings.

To use VIZA-KIM set the IRQ vector (\$17FE) to the address of the dump routine and turn on the new SST switch. Be sure the use P register at location \$F1 has the interrupt flag (bit 2) set to zero, since the object program must run with interrupts enabled. To use slow motion mode set \$E9 to the number of quarter seconds of delay desired, enter the address of the object program and press GO. Instructions will be executed one at a time after the desired delay. To stop execution hold down any key on the KIM keyboard. To use normal mode clear \$E9 to zero and enter the address of the object program. Operation will be the same as in KIM SST mode.

VIZA-KIM makes one aware of each change of the state of the processor as each instruction is executed. This makes bugs more easily spotted as well as giving one a better understanding of how the 6502 works.

μ

VIZA-KIM

```
PC    DATA
2008 C01A90
SP=FF 305748
X=06 Y=0A
A=00
P
NV BDIZC
00100000
```

```
PC    DATA
200A 90F885
SP=FF 305748
X=06 Y=0A
A=00
P
NV BDIZC
10100000
```

```
PC    DATA
2004 998000
SP=FF 305748
X=06 Y=0A
A=00
P
NV BDIZC
10100000
```

VIZA-KIM VERSION 1 SEPTEMBER 1979

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PROCESSOR REGISTER SAVEAREA

PCL * \$00EF
 PCH * \$00F0
 PREG * \$00F1
 SPUSER * \$00F2
 ACC * \$00F3
 YREG * \$00F4
 XREG * \$00F5

POINTL * \$00FA
 POINTH * \$00FB

EQUATES

ZERO * \$0000
 CR * \$000D
 LF * \$000A

LABELS

CRLF * \$1E2F PRINT CRLF
 START * \$1C4F ENTRY TO KIM
 PRTPNT * \$1E1E PRINT \$FA & \$FB
 OUTCH * \$1E40 PRINT CHARACTER
 PRTRYT * \$1E3B PRINT ACCUM IN HEX
 INITI * \$1E88 INIT I/O PORT
 TIMST * \$1707 START TIMER
 TIMOUT * \$1707 READ TIMER
 GOEXEC * \$1DC8 KIM GO ROUTINE
 GETKEY * \$1F6A READ KIM KEYBOARD

VIZA1 ORG

IRG STA ACC SAVE ACCUMULATOR
 STA STA PREG SAVE STATUS REGISTER
 PLA PLA PCL SAVE PROGRAM COUNTER
 STA STA POINTL
 PLA PLA PCH
 STA STA POINTH
 STA STA YREG SAVE Y REGISTER
 STX STX XREG SAVE X REGISTER
 TSX TSX SPUSER SAVE STACK POINTER
 SIX SIX INITS INIT I/O
 JSR JSR

0066: 3019 A9 EB LDAIM MSG PRINT HEADER
 0067: 3018 B5 EA STA MSGPTL /
 0068: 301D A9 30 LDAIM MSG /
 0069: 301F 20 D7 30 JSR MSGWRT
 0070: 3022 20 1E 1E JSR PRTPNT PRINT PC
 0071: 3025 A9 20 LDAIM
 0072: 3027 20 A0 1E JSR OUTCH
 0073: 302A A0 00 LDYIM \$00 CLEAR INDEX
 0074: 302C B1 FA LDYIM \$00 PRINT 3 BYTES OF DATA
 0075: 302E 20 CF 30 JSR PSVAV PRINT 3 BYTES OF DATA
 0076: 3031 C8 INY PROGRAM COUNTER
 0077: 3032 C0 03 CPYIM \$03
 0078: 3034 D0 F6 BNE DALUP
 0079: 3036 A9 0C LDAIM SPMSG MORE HEADING
 0080: 3038 85 EA STA MSGPTL /
 0081: 303A A9 31 LDAIM SPMSG /
 0082: 303C 20 D7 30 JSR MSGWRT LOAD STACK POINTER
 0083: 303F A5 F2 STA PPLO
 0084: 3041 85 EC JSR PRTRYT PRINT SP VALUE
 0085: 3043 20 3B 1E LDAIM
 0086: 3046 A9 20 JSR OUTCH
 0087: 3048 20 A0 1E LDAIM \$01
 0088: 304B A9 01 STA PPPI
 0089: 304D 85 ED LDYIM \$00
 0090: 304F A0 00 JSR MSGWRT
 0091: 3051 R1 EC STKCLUP
 0092: 3053 20 CF 30 LDYIM \$00 PRINT 3 BYTES FROM STACK
 0093: 3056 C8 JSR PSVAV
 0094: 3057 C0 03 INY
 0095: 3059 D0 F6 BNE STKCLUP
 0096: 305B A9 12 LDAIM XMSG MORE HEADING
 0097: 305D 85 EA STA MSGPTL /
 0098: 305F A9 31 LDAIM XMSG /
 0099: 3061 20 D7 30 JSR MSGWRT
 0100: 3064 A5 F5 LDA XREG
 0101: 3066 20 3B 1E JSR PRTRYT PRINT X REGISTER
 0102: 3069 A9 18 LDAIM YMSG
 0103: 306B 85 EA STA MSGPTL /
 0104: 306D A9 31 LDAIM YMSG /
 0105: 306F 20 D7 30 JSR MSGWRT
 0106: 3072 A5 F4 LDA YREG
 0107: 3074 20 3B 1E JSR PRTRYT PRINT Y REGISTER
 0108: 3077 A9 1C LDAIM XMSG MORE HEADING
 0109: 3079 85 EA STA MSGPTL /
 0110: 307B A9 31 LDAIM XMSG /
 0111: 307D 20 D7 30 JSR MSGWRT
 0112: 3080 A5 F3 LDA ACC
 0113: 3082 20 3B 1E JSR PRTRYT PRINT ACCUMULATOR
 0114: 3085 A9 24 LDAIM PMSG
 0115: 3087 85 EA STA MSGPTL /
 0116: 3089 A9 31 LDAIM PMSG /
 0117: 308B 20 D7 30 JSR MSGWRT
 0118: 308E A2 07 LDYIM \$07
 0119: 3090 A5 F1 LDA PREG
 0120: 3092 48 PHA
 0121: PLOOP
 0122: 3093 26 F1 ROL PREG
 0123: 3095 B0 04 BCS WUN
 0124: 3097 A9 30 LDAIM *0
 0125: 3099 D0 02 BNE OUTP
 0126: 309B A9 31 LDYIM *1
 0127: 309D 20 A0 1E JSR OUTCH
 0128: 30A0 CA DEX
 0129: 30A1 10 F0 BPL PLOOP

0001: 0000
 0002: 0000
 0003: 0000
 0004: 0000
 0005: 0000
 0006: 0000
 0007: 0000
 0008: 0000
 0009: 0000
 0010: 0000
 0011: 0000
 0012: 0000
 0013: 0000
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 0044: 0000
 0045: 0000
 0046: 0000
 0047: 0000
 0048: 0000
 0049: 0000
 0050: 0000
 0051: 0000
 0052: 0000 85 F3
 0053: 0002 60
 0054: 0003 85 F1
 0055: 0005 68
 0056: 0006 85 EF
 0057: 0008 85 FA
 0058: 000A 68
 0059: 000B 85 F0
 0060: 000D 85 FB
 0061: 000F 84 F4
 0062: 0011 86 F5
 0063: 0013 8A
 0064: 0014 86 F2
 0065: 0016 20 88 1E

0130: 30A3 6D	PLA	PHEG	RESTORE PHEG	0196: 3100 43	U	0226: 311E 20	.
0131: 30A4 85 F1	STA	BLOMO	SLOW MOTION IN EFFECT?	0197: 3101 20	.	0227: 311F 20	.
0132: 30A6 A5 E9	LDA	NOSLO	NO	0198: 3102 20	.	0228: 3120 20	.
0133: 30A8 F0 1F	BEQ	CRLF		0199: 3103 20	.	0229: 3121 41	.A
0134: 30AA 20 2F 1E	JSR	CRLF		0200: 3104 44	.	0230: 3122 3D	.
0135: 30AD 20 2F 1E	JSR	CRLF		0201: 3105 41	.	0231: 3123 00	.ZERO
0136: 30B0 A6 E9	LDA	BLOMO	YES, USE AS COUNT	0202: 3106 54	.A	0232: 3124 00	.CR
0137: 30B2 A9 F4	LDLAIM	\$F4	ABOUT A QUARTER SECOND	0203: 3107 41	.	0233: 3125 0A	.LF
0138: 30B4 8D 07 17	STA	TIMST	START TIMER	0204: 3108 00	.	0234: 3126 20	.
0139: 30B7 AD 07 17	LDA	TIMOUT	WAIT FOR TIMEOUT	0205: 3109 0A	.	0235: 3127 20	.
0140: 30BA F0 FB	BEQ	TLUPB		0206: 310A 20	.	0236: 3128 20	.
0141: 30BC CA	DEX	TLUPB	COUNT	0207: 310B 00	.	0237: 3129 20	.
0142: 30BD D0 F3	BNE	TLUPA		0208: 310C 00	.	0238: 312A 20	.
0143: 30BF 20 6A 1F	JSR	GETKEY	READ KEYBOARD	0209: 310D 0A	.	0239: 312B 50	.P
0144: 30C2 C9 15	CMPIM	\$15	ANY KEY PRESSED?	0210: 310E 53	.	0240: 312C 00	.CR
0145: 30C4 D0 03	BNE	NOSLO	YES, QUIT	0211: 310F 50	.	0241: 312D 0A	.LF
0146: 30C6 4C C8 1D	JMP	GOEXEC	NO, EXECUTE NEXT INSTRUCTION	0212: 3110 3D	.	0242: 312E 20	.N
0147: 30C9 20 2F 1E	JSR	CRLF		0213: 3111 00	.	0243: 312F 4E	.V
0148: 30CC 4C 4F 1C	JMP	START	RETURN TO KIM	0214: 3112 00	.	0244: 3130 56	.
0149: 30CE 20 2F 1E				0215: 3113 0A	.	0245: 3131 20	.B
0150: 30D0 20 2F 1E				0216: 3114 20	.	0246: 3132 42	.
0151: 30D2 20 2F 1E				0217: 3115 58	.	0247: 3133 44	.D
0152: 30D4 20 2F 1E				0218: 3116 3D	.	0248: 3134 49	.I
0153: 30D6 60				0219: 3117 00	.	0249: 3135 5A	.Z
0154: 30CF 84 EE	PSAVY	STY	SAVY	0220: 3118 20	.	0250: 3136 43	.C
0155: 30D1 20 3B 1E	JSR	PRIBYT		0221: 3119 59	.	0251: 3137 0D	.CR
0156: 30D4 A4 EE	LDY	SAVY		0222: 311A 3D	.	0252: 3138 0A	.LF
0157: 30D6 60	RTS			0223: 311B 00	.	0253: 3139 20	.
0158: 30D8 20 2F 1E				0224: 311C 00	.	0254: 313A 00	.ZERO
0159: 30DA 20 2F 1E				0225: 311D 0A	.		
0160: 30DC 20 2F 1E							

0161: 30DE 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0162: 30E0 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0163: 30E2 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0164: 30E4 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0165: 30E6 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0166: 30E8 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0167: 30EA 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0168: 30EC 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0169: 30EE 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0170: 30F0 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0171: 30F2 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0172: 30F4 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0173: 30F6 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0174: 30F8 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0175: 30FA 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0176: 30FC 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0177: 30FE 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0178: 30FF 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0179: 30FF 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0180: 30FF 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0181: 30FF 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0182: 30FF 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0183: 30FF 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0184: 30FF 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0185: 30FF 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0186: 30FF 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0187: 30FF 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0188: 30FF 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0189: 30FF 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0190: 30FF 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0191: 30FF 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0192: 30FF 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0193: 30FF 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0194: 30FF 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A
0195: 30FF 20 2F 1E	MSGWRT	STA	MSGPTR	HI POINTER BYTE IN A

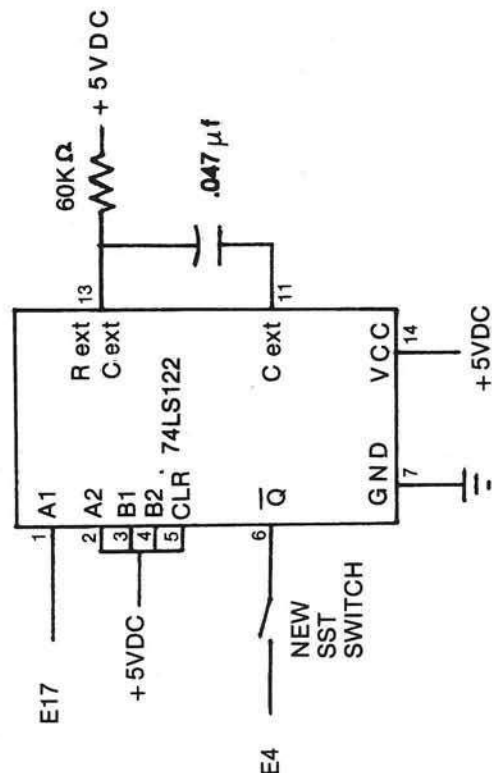
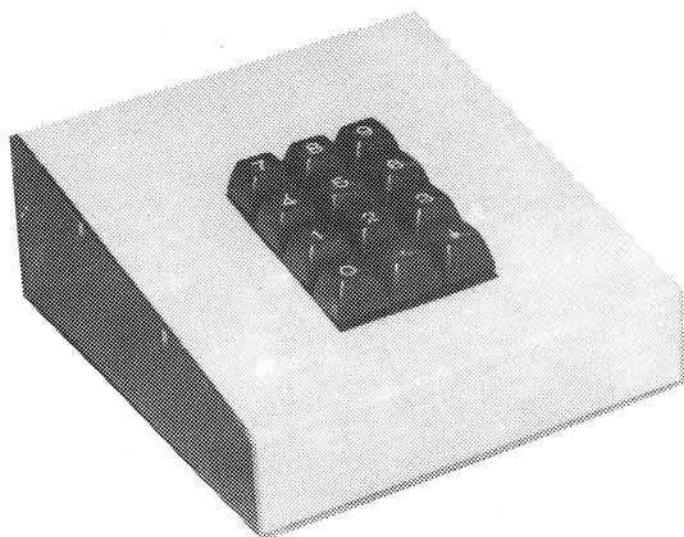


Figure 1: VIZA-KIM Circuit

OSI



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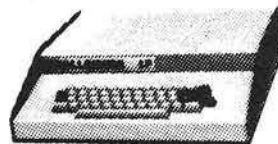


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Microbes & Updates

Bill Watts of Provincetown, Mass phoned in the following changes to Henk Wevers' article "Short-hand Commands for Superboard II and Challenger C1P BASICS" (24:25):

Page 26:

Line 028B Restore ↑H 68

Line 028F should be 67

0291 should be 65,

0292: 61

0295: 64

0298: 62

029A: 63

029E: 66

Page 27: Line 0236 should read A2 58, instead of A2 43.

With these changes, things should run smoothly.

Bill Crouch from California writes:

Line 63000 of the program XFILE.MAKER (23:11) was sent as "63000 REM XFILE.MAKER". The typesetter dropped the line number and used it as a title. The programs will not work unless there is a line 63000 in XFILE.MAKER so some of your readers might have problems with it.

Also, if you want to use REM KILLER on a program which has GOTO and GOSUB statements which refer to remark lines, you can change line 310 of REM KILLER to read:

```
310 PRINT ARRAY(Y);CHR$(58)
```

This will replace the REM statements with a colon. Although it doesn't save as much space as a complete removal of the REMs, the program will still work as before.

From Robert and Jon Prall of Silver Spring, Maryland found a problem in "Apple II Speed Typing Test with Input Time Clock" in the December issue of 1979.

On page 19:69 line 8406 reads in the published version, subtracting 159 from ASCII numbers assigned to the individual characters does not correspond to the position of characters the A\$.

The inclusion of the quotation mark at position three in the string is logical, but impossible because it causes a "Syntax Error" message, and a blank space should be substituted for it.

The corrected line should read:

```
8406 A$ = " !#$%&'()*+,-./0123456789;<=>
?@ABCDEFGHIJKLMN O PQRSTU VWXYZ"
```

The position of the spaces in the string is essential; the signs for greater than and less than must be included, as must the exclamation point. The author's inclusion of the slash, the small 'm' and a space at the end of the string appear to be additional errors.

With the corrections noted, the program runs very well.

Rev. James Strasma sends this update to his article entitled "Lower Case Lister" (25:11):

A revised printer ROM is now available for CBM printers without charge. It improves lower-case listings. However, the 20 characters that failed to print correctly in lower-case mode before still fail. "Lower Case Lister" is compatible with the new '04' printer ROM., and corrects all characters.

Challenger II Communications

~~~~~  
**Everything you need to turn your OSI with a 502 CPU board into a 'standard' communications terminal: hardware changes and the software to run it.**  
~~~~~

Peter Koski

As a college student, time becomes extremely valuable. A very poor use of this time is sitting waiting for a computer terminal. Corollary to Murphy's Law — there are never enough terminals; and who uses cards in this day and age?

Looking logically at the situation, there was only one answer, and my OSI Challenger II was it. Generously enough, Ohio Scientific has provided their 502 CPU board with all the foils needed for serial TTL/RS-232 input/output.

My answer was found. While others are sitting at terminals till the wee hours of the morning, I can be happily talking to Myron (our resident IBM) from the comfort of my room. Stereo in the background, fridge to the right ... what a life!

Of course this also opens up a whole horizon of dial-up bulletin board services as well as time-share systems. Options no computerist should live without.

Hardware

Before any software can be written, we'd better have some hardware to play with. Conveniently enough, the cassette port runs at 300 baud. No problem here. What about the -9 volts required by RS-232? Again we're allright: most modems only require a swing to zero level. Great!

First, let's start with the output side of the problem. Locate, using

OSI's 502 schematic package, the positions of U31, R55, R56, R57 and Q2. Some boards may or may not have U31 on them already. If not, install U31 using an I.C. socket. The values for the parts may be summarized:

U31	7404	(hex inverter)
R55, 57	10K Ω	($\frac{1}{4}$ watt)
R56	470 Ω	($\frac{1}{4}$ watt)
Q2	2N5226	

Carefully solder these to the board, confirming the positions. Check for any solder bridges which may crop up.

Input becomes only a bit more complicated. In order to maintain cassette capability, a switch must be inserted in the ACIA input line (the cassette input circuit loads down the line). Any SPDT switch which fits on the rear apron will suffice (Radio Shack's paddle switches fit the $\frac{3}{4}$ inch holes perfectly). Install the switch and we'll worry about wiring it later.

Again referring to the 502 layout sheet, locate U20, R61, R62, D3, and Q4. As with U31, U20 may or may not exist already. If not, be sure to use a socket when installing it. Once their positions are located, the following parts may be installed:

U21	7404	(hex inverter)
R61	10K Ω	($\frac{1}{4}$ watt)
R62	4.7K Ω	($\frac{1}{4}$ watt)
D3	1N914	
Q4	2N5225	

Be certain the board looks right before continuing on.

Going to pin 2 of the ACIA (U3) is the RX DATA foil. Cut this foil at some convenient point and solder the center terminal lead of the switch to the ACIA side of the cut. Solder one of the other leads to the other side of the break. In this switch position, cassette operation is as normal. Back to the newly installed U20. Locate the foil from pin 2 and cut it. To the U20 side of this foil, solder the remaining lead of the select switch. In this switch position, RS-232 input will be routed to the ACIA. A good thought would be to install a 3-pin in-line connector somewhere between the board and the select switch.

A standard RS-232 connector may also be added to the rear apron. The RX DATA is now at pin 1 of connector J3 and TX DATA at pin 7 of J3. All the even pins of J3 are ground. (-9 volts is bussed on the backplane, just add your supply if needed).

Unless you feel confident in your soldering abilities, you may want to let a trustworthy friend do the work for you. It only takes half an hour or so, but errors could be disastrous — and it's your own fault.

What you are now left with is an RS-232 port which resides at FC00 (same as cassette port). The input is selectable: cassette or 300 baud RS-232. Output is always there, allowing for convenient printer listings of programs being SAVED to

tape. The uses and tricks that can be implemented are too numerous to list; you'll find them yourself.

As for the modem, the Novation Cat is probably the top of the line if you can afford it. I have used it with excellent results over phone lines which would have made speech recognition rough, and I have not lost a bit. Plus it offers answer in addition to originate mode.

Software

Two options are now possible, and I've tried both. OSI's BASIC is fast enough to service the port via PEEKs and POKEs. However the draw-back is that it is very difficult to output BASIC control symbols (comma or colon). A BASIC routine is the easiest route if you wish to set up a system for down-loading locally-editted files. This is a very handy routine which works well. See the two BASIC programs below.

On the other hand, the following assembler routine turns your brilliant computer into an ignorant terminal. Running with this system, the Challenger II behaves like a standard ASCII terminal, except the obscure CTRL functions will appear as OSI graphics.

The package includes a protected field at the top of the screen to provide a 'touch of class' without taking too much screen space.

As written, the routine is loaded into 2000 hex. However, it could be relocated fairly easily. The only monitor routine called is the keyboard input routine, whose entry point in the 65V MONITOR is FEED hex (should be the same for all systems). The program continually polls both the port and the keyboard, then displays or output (as the case may be) whichever is requesting service at the time. Auto-line feed is provided only on out-put (as the case may be) whichever is requesting service at the time. Auto-line feed is provided only on out-put carriage return. Most dial-ups will provide line-feed with carriage return.

As an added note of interest, the RS-232 outputs from both the Challenger II and modem are able to handle two loads. This means that a

printer could be used on one line (normally input) to provide hard-copy as desired. Certainly no computer system should be without RS-232 communications capabilities.

My system has behaved flawlessly through "mega-hours" of hard use. Good luck, and don't make Ma Bell too rich with your calls!

μ

Peter is a sophomore at Rensselaer Polytechnic Institute majoring in Biomedical Engineering — Electronics option. His minor is in Computer Systems. He has an Ohio Scientific Challenger C2-4P which he uses for both academic and hobby purposes. Pete started his programming in BASIC and recently added assembler capability to his machine's repertoire.

```

1000 REM —          TERMINAL OPERATING SYSTEM
1010 REM
1020 REM          VERSION 3.2
1022 REM
1025 REM — PETER KOSKI          12/79
1030 REM
1035 REM — STRIKING EITHER 'SHIFT' KEY ENTERS
1037 REM TRANSMIT MODE ( ? PROMPT)
1038 REM
1040 REM — WHEN ENTERING A COMMA OR COLON, THE
1050 REM 'CTRL' MUST ALSO BE DEPRESSED
1060 REM
1090 REM — UNDERSCORE IS CONTROL HYPHEN
1100 REM
1110 REM — OR OPERATOR IS CONTROL I
1120 REM
1130 REM -- NOT OPERATOR IS #
1140 REM
2000 POKE 530,1: POKE 57000,1: POKE 64512,1
2010 IF (PEEK(64512)AND1)THEN PRINT CHR$(PEEK(64513));
2020 IF (PEEK(57000)=1) THEN 2010
2030 INPUT TX$
2040 FOR TX=1 TO LEN(TX$)
2050 FOR DLA=1 TO 15: NEXT DLA
2060 IF ASC(MID$(TX$,TX,1))=122 THEN POKE 64513,58: GOTO 2100
2065 IF ASC(MID$(TX$,TX,1))=100 THEN POKE 64513,44: GOTO 2100
2070 IF ASC(MID$(TX$,TX,1))=109 THEN POKE 64513,95: GOTO 2100
2080 IF ASC(MID$(TX$,TX,1))=113 THEN POKE 64513,124: GOTO 2100
2090 IF ASC(MID$(TX$,TX,1))= 35 THEN POKE 64513,126: GOTO 2100
2095 POKE 64513,ASC(MID$(TX$,TX,1))
2100 NEXT TX
2150 FOR DLA=1 TO 15: NEXT DLA: POKE 64513,13
2160 FOR DLA=1 TO 15: NEXT DLA: POKE 64513,10
2170 GOTO 2010

```

OK

```

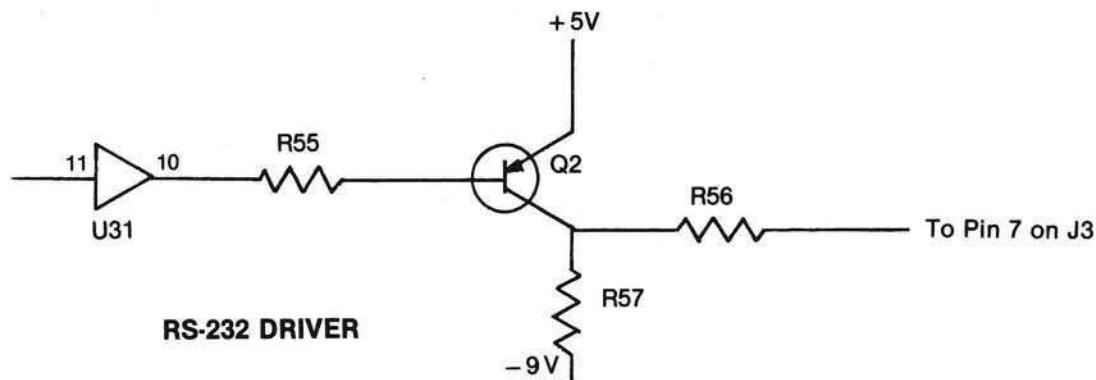
1000 REM          TERMINAL OPERATING SYSTEM
1001 REM
1002 REM          VERSION 3.3
1003 REM
1004 REM -- PETER KOSKI          11/79
1005 REM
1006 REM -- LOCAL FILE EDITOR / TERMINAL SYSTEM PACKAGE
1007 REM
1009 DIM LINE$(60), TEMP$(64)
1010 FOR CLS=1 TO 20: PRINT: NEXT CLS
1020 PRINT "      >>>>  TOS  VERSION 3.3  <<<<"
1030 PRINT:PRINT:PRINT "  --  LOAD  (LOAD LOCAL FILE)"
1040 PRINT:PRINT "  --  EDIT  (EDIT LOCAL FILE)"
1050 PRINT:PRINT "  --  TH00  (ENHANCED TERMINAL MODE)"
1060 PRINT:PRINT:PRINT:INPUT MOD$
1070 IF LEFT$(MOD$,4)="LOAD" THEN ID=1
1080 IF LEFT$(MOD$,4)="EDIT" THEN ID=2
1090 IF LEFT$(MOD$,4)="TH00" THEN ID=3
1100 ON ID GOSUB 2000, 3000, 4000
1110 GOTO 1010
2000 REM -- LOAD LOCAL FILE
2010 FOR CLS=1 TO 14:PRINT:NEXT CLS
2015 FOR CH=1 TO 60: LINE$(CH)=CHR$(32): NEXT CH
2020 PRINT "      >>>  LOCAL FILE LOADER  <<<"
2025 PRINT:PRINT
2030 PRINT:PRINT "  --  OR operator is CTRL-I"
2035 PRINT:PRINT "  --  NOT operator is #"
2040 PRINT:PRINT "  --  UNDERSCORE is CTRL HYPHEN"
2050 PRINT:PRINT "  --  CTRL must be depressed when"
2060 PRINT "      entering a COMMA or COLON"
2070 PRINT:PRINT "  --  $ENDFILE marks end-of-file"
2080 PRINT:PRINT: LN=1
2090 INPUT LINE$(LN)
2100 IF LEFT$(LINE$(LN),8)="$ENDFILE" THEN RETURN
2110 LN=LN+1: GOTO 2090
3000 REM -- EDIT LOCAL FILE
3010 FOR CLS=1 TO 14: PRINT: NEXT CLS
3060 PRINT "      >>>  LOCAL FILE EDITOR  <<<"
3070 PRINT:PRINT
3080 PRINT:PRINT "  --  INSERT , LINE NUMBER PRECEEDING INSERT"
3090 PRINT "      LOCATION DESIRED"
3100 PRINT:PRINT "  --  DELETE , LINE NUMBER TO BE DELETED"
3105 PRINT:PRINT "  --  LIST"
3110 PRINT:PRINT "  --  DONE"

```

```

3120 PRINT:PRINT:INPUT "OPTION";OPTN$
3140 IF LEFT$(OPTN$,4)="LIST" THEN ID=3: GOTO 3180
3150 IF LEFT$(OPTN$,4)="DONE" THEN RETURN
3160 INPUT "  LINE";LINE
3170 IF LEFT$(OPTN$,6)="INSERT" THEN ID=1
3175 IF LEFT$(OPTN$,6)="DELETE" THEN ID=2
3180 ON ID GOSUB 3200, 3260, 3310
3190 GOTO 3120
3200 FOR B= (LN+1) TO (LINE+1) STEP -1
3210 LINE$(B)=LINE$(B-1)
3220 NEXT B
3230 PRINT:INPUT INSERT$
3240 LINE$(LINE+1)=INSERT$
3250 LN=LN+1: RETURN
3260 FOR C=LINE TO LN-1
3270 LINE$(C)=LINE$(C+1)
3280 NEXT C
3290 LINE$(LN)=CHR$(32)
3300 LN=LN-1: RETURN
3310 PRINT:PRINT: FOR D=1 TO LN
3320 PRINT D, LINE$(D)
3330 NEXT D: RETURN
4000 REM -- ENHANCED TERMINAL OPERATING SYSTEM
4010 FOR CLS=1 TO 10: PRINT: NEXT CLS
4020 PRINT "      >>>  ENHANCED TERMINAL OPERATING SYSTEM  <<<"
4030 PRINT:PRINT
4032 PRINT:PRINT "  --  Striking either SHIFT key enters"
4035 PRINT "      TRANSMIT mode ( ? prompt )"
4040 PRINT:PRINT "  --  OR operator is CTRL-I"
4050 PRINT:PRINT "  --  NOT operator is #"
4055 PRINT:PRINT "  --  UNDERSCORE is CTRL HYPHEN"
4060 PRINT:PRINT "  --  CTRL must be depressed when"
4065 PRINT "      entering a COMMA or COLON"
4075 PRINT:PRINT "  --  DUMP (DUMPS LOCAL FILE)"
4076 PRINT:PRINT "  --  DONE"
4078 PRINT:PRINT
4080 POKE 530,1: POKE 57000,1: POKE 64512,1
4082 IF (PEEK(64512)AND1) THEN PRINT CHR$(PEEK(64513));
4083 IF (PEEK(57000)=1) THEN 4082
4084 INPUT TX$
4085 IF LEFT$(TX$,4)="DUMP" THEN 5000
4087 IF LEFT$(TX$,4)="DONE" THEN RETURN
4100 FOR TX=1 TO LEN(TX$)
4110 FOR DLA=1 TO 15: NEXT DLA

```

```

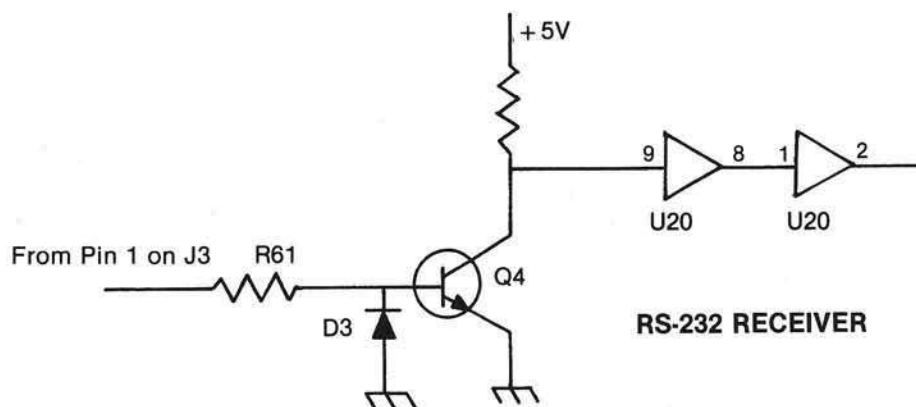
4120 IF ASC(MID$(TX$,TX,1))=122 THEN POKE 64513,50: GOTO 4200
4130 IF ASC(MID$(TX$,TX,1))=100 THEN POKE 64513,44: GOTO 4200
4140 IF ASC(MID$(TX$,TX,1))=109 THEN POKE 64513,95: GOTO 4200
4150 IF ASC(MID$(TX$,TX,1))=113 THEN POKE 64513,124: GOTO 4200
4160 IF ASC(MID$(TX$,TX,1))=35 THEN POKE 64513,126: GOTO 4200
4170 POKE 64513,ASC(MID$(TX$,TX,1))
4200 NEXT TX
4210 FOR DLA=1 TO 15: NEXT DLA: POKE 64513,13
4220 FOR DLA=1 TO 15: NEXT DLA: POKE 64513,10
4230 GOTO 4002
5000 REM -- LOCAL FILE DUMP ROUTINE
5010 FOR CLS=1 TO 28: PRINT: NEXT CLS
5020 PRINT "    >>>  LOCAL FILE DUMP ROUTINE  <<<"
5030 PRINT:PRINT:PRINT:PRINT
5050 FOR G=1 TO LN

```

```

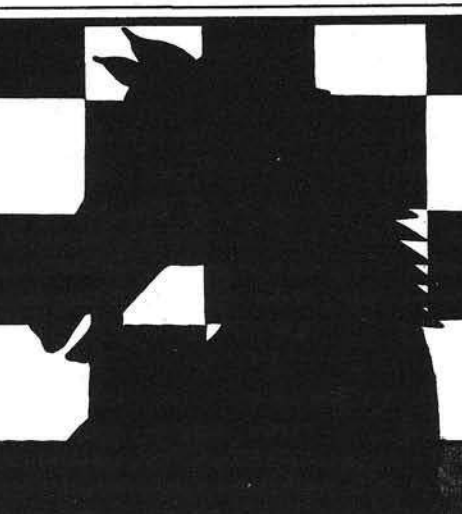
5060 FOR H=1 TO LEN(LINE$(G))
5070 TEMP$(H)=MID$(LINE$(G),H,1)
5080 IF TEMP$(H)="1" THEN TEMP$(H)=","
5090 IF TEMP$(H)="(" THEN TEMP$(H)=";"
5100 IF TEMP$(H)="2" THEN TEMP$(H)=":"
5110 IF TEMP$(H)="m" THEN TEMP$(H)=CHR$(95)
5120 IF TEMP$(H)="q" THEN TEMP$(H)=CHR$(124)
5125 IF TEMP$(H)="#" THEN TEMP$(H)=CHR$(126)
5130 NEXT H
5140 LT=LEN(LINE$(G)): LINE$(G)=" "
5150 FOR I=1 TO LT: LINE$(G)=LINE$(G)+TEMP$(I): NEXT I
5155 FOR WT=1 TO 1200: NEXT WT
5160 POKE 517,255: PRINT RIGHT$(LINE$(G),LT): POKE 517,0
5180 NEXT G
5190 GOTO 4000

```



CHALLENGER II												
TERMINAL OPERATING SYSTEM												
BY PETER KOSKI												
0010:										0540: 203C 59	=	'Y
0020:										0550: 203D 53	=	'S
0030:										0560: 203E 54	=	'T
0040:										0570: 203F 45	=	'E
0050: 2000				TOS	ORG	\$2000				0580: 2040 4D	=	'M
0060:										0590: 2041 A2 OE		LDXIM \$OE
0070: 2000 A9 20					LDAIM	\$20				0600: 2043 BD 19 20	LOOPB	LDAX \$2019
0080: 2002 A0 08					LDYIM	\$08				0610: 2046 9D EC DO		STAX \$DOEC
0090: 2004 A2 00					LDXIM	\$00				0620: 2049 CA		DEX
0100:										0630: 204A DO F7		BNE LOOPB
0110: 2006 9D 00 DO	LOOP				STAX	\$D000				0640: 204C A2 19		LDXIM \$19
0120: 2009 E8					INX					0650: 204E BD 27 20	LOOPC	LDAX \$2027
0130: 200A DO FA					BNE	LOOP				0660: 2051 9D 61 D1		STAX \$D161
0140: 200C EE 08 20					INC	\$2008				0670: 2054 CA		DEX
0150: 200F 88					DEY					0680: 2055 DO F7		BNE LOOPC
0160: 2010 DO F4					BNE	LOOP				0690: 2057 A2 40		LDXIM \$40
0170: 2012 A9 DO					LDAIM	\$DO				0700: 2059 A9 94		LDAIM \$94
0180: 2014 8D 08 20					STA	\$2008				0710: 205B 9D BF D1	LOOPD	STAX \$D1BF
0190: 2017 4C 41 20					JMP	\$2041				0720: 205E CA		DEX
0200: 201A 43					=	'C				0730: 205F DO FA		BNE LOOPD
0210: 201B 48					=	'H				0740: 2061 AD 00 FC	LOOPE	LDA \$FC00
0220: 201C 41					=	'A				0750: 2064 4A		LSRA
0230: 201D 4C					=	'L				0760: 2065 BO 1E		BCS LOCA
0240: 201E 4C					=	'L				0770: 2067 EA		NOP
0250: 201F 45					=	'E				0780: 2068 A9 02		LDAIM \$02
0260: 2020 4E					=	'N				0790: 206A 8D 00 DF		STA \$DFOO
0270: 2021 47					=	'G				0800: 206D AE 00 DF		LDX \$DFCO
0280: 2022 45					=	'E				0810: 2070 DO 20		BNE LOCB
0290: 2023 52					=	'R				0820: 2072 0A		ASLA
0300: 2024 20					=	'				0830: 2073 FO EC		BEQ LOOPE
0310: 2025 20					=	'				0840: 2075 4C 6A 20		JMP \$206A
0320: 2026 49					=	'I				0850: 2078 A0 B9		LDYIM \$B9
0330: 2027 49					=	'I				0860: 207A A2 00		LDXIM \$00
0340: 2028 54					=	'T				0870: 207C C8	LOOPF	INX
0350: 2029 45					=	'E				0880: 207D FO E2		BEQ LOOPE
0360: 202A 52					=	'R				0890: 207F E8		INX
0370: 202B 4D					=	'M				0900: 2080 FO FA		BEQ LOOPF
0380: 202C 49					=	'I				0910: 2082 4C 7F 20		JMP \$207F
0390: 202D 4E					=	'N				0920: 2085 AD 01 FC	LOCA	LDA \$FC01
0400: 202E 41					=	'A				0930: 2088 29 7F		ANDIM \$7F
0410: 202F 4C					=	'L				0940: 208A FO D5		BEQ LOOPE
0420: 2030 20					=	'				0950: 208C 20 BC 20		JSR \$20BC
0430: 2031 4F					=	'O				0960: 208F 4C 61 20		JMP \$2061
0440: 2032 50					=	'P				0970: 2092 20 ED FE	LOCB	JSR \$FEED
0450: 2033 45					=	'E				0980: 2095 C9 OD		CMPIM \$OD
0460: 2034 52					=	'R				0990: 2097 FO 09		BEQ LOCD
0470: 2035 41					=	'A				1000: 2099 8D 01 FC		STA \$FC01
0480: 2036 54					=	'T				1010: 209C 20 BC 20		JSR \$20BC
0490: 2037 49					=	'I				1020: 209F 4C 78 2C		JMP \$2078
0500: 2038 4E					=	'N				1030: 20A2 8D 01 FC	LOCD	STA \$FC01
0510: 2039 47					=	'G				1040: 20A5 20 BC 20		JSR \$20BC
0520: 203A 20					=	'				1050: 20A8 A0 0A		LDYIM \$0A
0530: 203B 53					=	'S				1060: 20AA AD 00 FC	LOCE	LDA \$FC00

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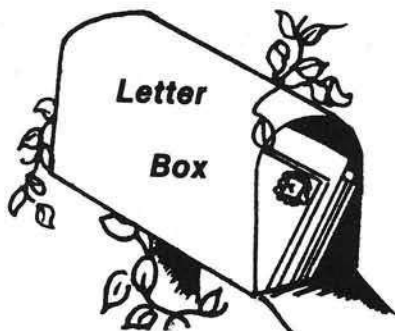
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The following letters are in response to the editorial that appeared in the March issue of *Micro*. The editorial encouraged readers to write to us about what they'd like to see in a 6516. Here are two of those responses.

Dear Bob,

I just read the March issue, and I am responding to your editorial on the "want list" for a 6516. Here's my list, with the most-wanted features first:

1. Let **all** op-codes use **all** possible addressing modes, so I won't need a wall chart to tell me if this op-code is allowed to use this addressing mode. Haven't you ever written a neat piece of code using, for example, ASLIY (Indirect Indexed), only to find that ASLIY isn't allowed? I may never use INCAY (Absolute Indexed by Y), but I sure would like to know that it's there if I ever want it. In my opinion, this is the best feature of the new 6809: there are no "holes" in the op-code-versus-address-mode matrix.

2. Change "Zero Page" to "Fast Page", and add the instruction SFP XX (set Fast Page). With the 6502, page zero is prime real estate. With this change, I can turn any page into prime real estate.

3. BRA (Branch Always). This only saves one byte per use (over CLC, BCC), but those bytes do add up.

4. BAS (Branch Always to Subroutine). In other words, a **relative** JSR. This would allow relocatable code without the hassle of subroutine-address look-up tables and zero-page trickery.

5. INA, DEA. Increment and decrement accumulator.

6. PHX, PLX, PHY, PLY. Push and pull X and Y.

7. EAX, EAY, EXY. Exchange A&X, A&Y, X&Y.

8. SSP XX (Set Stack Page). This would make the use of multiple stacks a lot easier.

9. DEL XX (Delay XX Cycles). Better yet, make it DEL XX XX. This would be neater than wait loops, or strings of NOPs and such when equalizing branches. Even better, DEL NN XX..., where NN designates number of following bytes that define delay time.

10. With all of the above, who needs 16 bytes?

Mel Evans
Ann Arbor, MI

Dear Dr. Tripp,

I am responding to your question concerning a revised or improved 6502. My first request would be to fill in all those presently used OP codes. I really need more indirect addressing modes like

LDA (\$1234)

STA (\$1234)

[absolute indirect without index]

I would also like an increment (and decrement) instruction which automatically adds the carry into the next byte. I guess this is a 16 byte instruction.

Of course PHX and PLX would also be helpful to save a few bytes. A new chip would have to be hardware compatible with my present system or I would have no real interest in it.

I heard that several years ago MOS Technology had some experimental improved 6502's. However, this program ended when they were brought out by Commodore.

Dr. Morris
Midland, MI

*I had really expected to receive more suggestions on improvements for the 6502. Does the limited response indicate that you are all **totally** satisfied with the 6502 as it is? That **would** suprise me! Even if you only have one small but significant idea, let us know about it. It could make a difference to the future development of the 6502.*

μ

AIM 65 File Operations

~~~~~

**AIM BASIC does not have any file access statements. A discussion of this problem and programs to solve it are presented. These programs will greatly enhance the AIM BASIC, and provide some insight into the workings of the AIM.**

~~~~~

Christopher J. Flynn

Introduction

By now, most readers of MICRO are familiar with the physical characteristics of the Rockwell AIM 65 microcomputer. The AIM 65 is a computer which comes complete with keyboard, display, and a printer. A few additional ICs will add Microsoft BASIC, a two-pass assembler, and an extra 3K of RAM. All of this can be housed in an attractive case. The result is a truly personal computer. It can be easily moved around the home or office to where the user is. There is no concern about detached video monitors, expansion interfaces, cables, and the like. The AIM is indeed a very versatile computing engine.

This attractiveness of the AIM 65 hardware was the factor that ultimately prompted my wife and me to purchase one. We quickly learned how to operate it. It comes with a one inch thick users manual! Rockwell deserves a lot of credit for not only paying attention to documentation, but also for doing such a good job with it.

Upon contemplating our first home applications, we discovered that not much had been written about the application software capabilities of the AIM. We were happily creating data bases with the very nifty built-in text editor. Our intention was to next use BASIC to perform the desired calculations on the data. This is where we ran into a problem. AIM's BASIC has no file access statements! None of the pro-

vided documentation or any other 6502 sources could provide an answer to this dilemma. Did that mean that all that data which we had entered was useless? We will show that the answer to this question is a resounding NO!

We have developed a simple machine language subroutine. This subroutine will allow a BASIC program to read any AIM 65 text file. This includes data entered from the text editor as well as BASIC source program tapes themselves. The subroutine is easy to use. It does some error checking to prevent simple mistakes from ruining your day. It will also tell BASIC when the end of a file has been reached. As a bonus, the subroutine is completely position-independent and ROMable.

Definitions

Before describing our software, we will define a few commonly used terms in AIM 65 context. This will benefit individuals who are just learning to use their AIM's and also MICRO readers who may not be aware of the AIM's capabilities.

File: A file is a collection of data. AIM 65 files may reside on external media such as audio tape or paper tape. AIM 65 audio tape files may, in turn, be in AIM or KIM format. We will be concerned only with AIM 65 format audio tape files.

Each file is given a file name. The file name may be from one to five characters long.

There are two types of AIM 65 audio tape files. One type contains object code data. The other type contains text (or ASCII) data. The subroutine we are presenting will handle only text files.

The AIM 65 has a dual cassette interface. A file may be read (or written) from either drive number 1 or drive number 2. Incidentally, we have found this feature to be very handy.

Block: A block is the unit of information transferred to and from memory and the audio cassette recorder.

All AIM format tape files are blocked. The format of text file blocks is described in the Users Manual. Suffice it to say, each block in any given file will contain the same number of bytes. (The exact block length is a function of the number of leading SYN characters.) Each block, though, will always contain 79 bytes of text data. If necessary, the last block will be padded with zeroes.

Line or Record: A line or record is the unit of information transferred to and from a program and the AIM monitor.

In a text file the lines will naturally contain ASCII data. The maximum line length can vary. The text editor imposes a 60 character limit on lines, while BASIC limits lines to 72 characters. The end of a line, in either case, is marked with a carriage return.

Now here is where it gets tricky. Each block will always contain 79 data bytes. Since the lines can vary in length, a line may be either wholly contained within a block or it may span a block. The machine decides if a line will fit in a block. If not, the line is split in two. This may sound imposing, but don't worry about it. We'll show how this situation is handled later.

End of File: The occurrence of two successive carriage returns on a text file denotes that there are no more lines of data on the file. Upon detection of end of file, we want the BASIC program to stop and not to attempt any more read operations.

Machine Language Subroutine:

"Although Basic is a high level language, it does allow us to communicate with routines that are written in 6502 machine or assembly language. Such routines are known as machine language subroutines."

Appendix F of the *BASIC Reference Manual* goes into the details on how to make a machine language subroutine and BASIC talk to each other.

Approach

Getting back on track now, the problem we wish to solve is stated as follows:

Develop a capability for making AIM 65 text files accessible to BASIC. One entire line of text should be passed to BASIC at a time. Lastly, BASIC should be informed when an end of file has been detected.

Note that from our earlier definitions, a line may be wholly contained in or may span a block. A key requirement that the subroutine must meet is the reconstruction of text lines when necessary. To satisfy all these requirements both the monitor subroutines and the BASIC USR function will be used.

Two AIM monitor subroutines which we chose for use in the machine language subroutine are:

WHEREI located at \$E848

INALL located at \$E993

These subroutines are described in

the Users Guide. WHEREI asks the user what the current input device will be. Assuming that the user responds with 'T' (for audio tape in AIM format), WHEREI will then ask for the name of the file desired. It will then locate the file on the tape. INALL reads a character from the current input device. If the current input device is an audio tape, INALL will see to the tasks of properly handling lines. INALL will start and stop the tape recorder as necessary in order to obtain a complete line. Thus, two of our requirements are already solved.

Interfacing a machine language subroutine to BASIC is straightforward. The BASIC program simply has to poke the address of the machine language program into memory locations \$04 and \$05. The next step is to invoke the USR function. This will start up the machine language subroutine. The *BASIC Reference Manual* tells us how to pass a single numeric value to and from BASIC. We will use this feature to pass the line length and end of file indicator to BASIC.

There is one interface problem remaining. That is, how do we pass the text line from the machine language subroutine to BASIC? The USR function limits us to a numeric value. Well, we will be bold and make an assumption. Then we will design the subroutine to fit the assumption. Assume that the BASIC program has defined a character string variable named A\$. Furthermore, assume that the A\$ is 80 bytes long. We can then design the machine language subroutine so that it will locate A\$ in BASIC's memory and store the text data there. If A\$ is guaranteed to be 80 bytes long, we can be sure that text editor and BASIC lines can be read.

There are other approaches to reading these text files. For example, the USR function can be used to call WHEREI. The AIM 65 can then be put in the tape mode. At this point, the BASIC program can issue INPUT statements to read data directly from the tape. This approach is very simple and to the point. However, it suffers from two disadvantages. First of all, since the input device was changed to a tape, the keyboard is deactivated for the

entire duration of the file read. This can be nasty, especially if your program requires some input from the user as it is running. The second disadvantage is that the data on the tape must be in the proper format to be processed by the INPUT statement. This means that there must be commas between values and that string data may need to be enclosed in quotation marks.

At the expense of a machine language subroutine, we have developed a method of reading AIM text files which is completely general. Any text file, including BASIC source programs, can now be read with BASIC. We have addressed the problems mentioned above. The AIM 65 is put in the tape mode only as long as it takes to read one line. The data on the tape can be in any format - you do not have to worry about commas and quotation marks.

Loading the Subroutine

Although our listings show that the subroutine is located at \$7C00, the subroutine is completely position-independent. This means that you can put it anywhere in memory that you like. You will not have to change a single byte of code. Of course, you will have to remember where you put it because BASIC will need to know.

The hex dump in Figure 1 is probably easier to work with when initially entering the machine code. If you prefer to enter the code in instruction format using Figure 2, just be careful of the absolute addresses which appear as branch operands. For ease of future use, you will probably want to store the machine code on tape. Thereafter, the subroutine can be loaded with the 'L' monitor command.

When bringing up BASIC, be sure to respond properly to the MEMORY SIZE question. Respond with the difference of the number of bytes of RAM in your system minus 164 bytes for the subroutine. For example, MEMORY SIZE in a 4K system would be 4096 - 164 or 3932.

Procedure

We hope that the subroutine has been put together so that it is easy

to use. Only three steps are required to read AIM 65 text files:

1. Open the file.
2. Invoke the USR function.
3. Test the USR function return code.

Step 1 - Open the File

A file is opened by zeroing memory location \$F5 (245 decimal). This causes the subroutine to invoke WHEREI in the AIM monitor. In BASIC we open a file as follows:

```
10 POKE 245,0
```

If you intend to read more than one file in the same BASIC program, you must open each one of them at the appropriate time with a POKE statement. Only one file can be open at a time.

Step 2 - Invoke the USR Function

One text line or record will be returned to the BASIC program each time the USR function is used. We will illustrate this in BASIC:

```
20 A$ = ""
30 FOR I = 1 TO 80
40 A$ = A$ + "*"
50 NEXT
60 POKE 4,0
70 POKE 5,124
80 L = USR (0)
```

Lines 20 through 50 set up A\$ as an 80 byte character string in accordance with our design criteria. If the BASIC program does not alter the length of A\$ during subsequent processing, these lines could be moved to the section of the BASIC program that opens the file. The important thing to remember is that the subroutine will insist that A\$ is 80 bytes long — no more or no less.

The contents of A\$ prior to calling the subroutine, however, do not matter. Before giving you any data, the subroutine will always blank out A\$. Thus, you are guaranteed not to encounter any data left over from a previous line.

Lines 60 and 70 are very important! They tell BASIC where the machine language subroutine is located. Line 60 POKes the low order byte of the address (expressed in decimal) into memory location \$04. Similarly, line 70 POKes the

high order byte of the address into memory location \$05. In our example, the machine language subroutine is located at \$7C00. Make sure you tailor lines 60 and 70 for your system.

If this is the only machine language program that your BASIC program is using, the two POKes may also be included as part of the file opening logic.

Finally, line 80 invokes the USR function. This causes BASIC to call our machine language program. We are not passing a value to the machine language subroutine. The 0 is just a dummy argument. The machine language subroutine will read the next text line from tape and give it back to us as A\$. BASIC will resume processing with the next statement after line 80.

Step 3

Test the USR Function Return Code

In line 80, the USR function passed a value back to the variable L. We call this value a return code. It can be assigned to any numeric variable - it doesn't have to be L. The value of the return code tells us the status of the read operation.

- a. Return code is less than 0

If the return code is negative, this means that an error condition has been detected. Probable error conditions are that A\$ was undefined or not 80 bytes long. (The AIM monitor worries about catching read errors.)

- b. Return code is equal to 0

The return code will be set to zero when end of file is reached. No special action is required to "close" the file as it is done automatically.

- c. Return code is greater than 0

A successful read operation will be signalled by a return code which is greater than zero. Furthermore, the return code will tell you the actual number of data bytes which were stored in A\$. In other words, it will tell you the line length.

WARNING: Under no circumstances should another read be executed after end of file has been detected. If this should happen, you may have to hit the reset switch to regain control.

We might finish our example this way:

```
90 IF L < 0 THEN STOP
100 IF L = 0 THEN PRINT "DONE":END
110 PRINT LEFT$(A$,L)
120 GOTO 80
```

Lines 90 and 100 terminate the program on an end of file or error condition respectively. Line 110 prints the text line. Line 120 branches back to read the next text line.

Summing It Up

Our sample program is printed in its entirety in Figure 3. Make a couple test files with the text editor. Run the test files through our sample program. You should see the lines of data that you entered printing out one by one. If you encounter any problems, go back and check the machine code carefully. Make sure that you've POKed \$04 and \$05 with the correct address.

We hope that this capability to read text files adds a new dimension to your computing.

Figure 1

```
M>=7C00 AD 12 A4 48
< > 7C04 A5 75 85 F0
< > 7C08 A5 76 85 F1
< > 7C0C A5 77 C5 F0
< > 7C10 D0 12 A5 78
< > 7C14 C5 F1 D0 0C
< > 7C18 A0 FF A2 FF
< > 7C1C 68 8D 12 A4
< > 7C20 8A 6C 08 B0
< > 7C24 A0 00 B1 F0
< > 7C28 C9 41 D0 07
< > 7C2C C8 B1 F0 C9
< > 7C30 80 F0 0D 18
< > 7C34 A5 F0 69 07
< > 7C38 85 F0 90 D0
< > 7C3C E6 F1 D0 CC
< > 7C40 A0 02 B1 F0
< > 7C44 99 F0 00 C8
< > 7C48 C0 05 D0 F6
< > 7C4C A4 F2 C0 50
< > 7C50 D0 C6 88 A9
```

```

< > 7C54 20 91 F3 88
< > 7C58 10 FB A5 F5
< > 7C5C D0 08 20 48
< > 7C60 E8 AD 12 A4
< > 7C64 85 F6 A0 00
< > 7C68 A5 F6 8D 12
< > 7C6C A4 20 93 E9
< > 7C70 C9 0A F0 F9
< > 7C74 C9 0D D0 0A
< > 7C78 C5 F5 85 F5
< > 7C7C F0 08 A2 00
< > 7C80 F0 9A 91 F3
< > 7C84 85 F5 C8 D0
< > 7C88 DF A0 00 AD
< > 7C8C 34 A4 D0 0A
< > 7C90 AD 00 A8 09
< > 7C94 10 8D 00 A8
< > 7C98 D0 E4 AD 00
< > 7C9C A8 09 20 8D
< > 7CA0 00 A8 D0 DA
<

```

Subroutine Logic

We've included in this section a technical description of how the machine language subroutine operates. This should give you enough information to modify the subroutine to fit your particular needs.

Figure 4 depicts the logic of the machine language subroutine. The logic is described through the use of Warnier-Orr diagrams. Readers who are not familiar with these diagrams should refer to the December '77, January '78, and March '79 issues of *BYTE*. Very basically, Warnier-Orr diagrams are interpreted as follows. The sequence in which operations are performed is given by reading from the top of the diagram to the bottom. The hierarchy of functions flows from left to right. As we go through the actual subroutine logic, the power of this design technique will become more apparent.

Figure 5 summarizes the use of zero page variables. These locations are shared with the text editor. However, since the text editor and BASIC do not operate concurrently, there is no conflict.

Upon entry to the subroutine, an AIM monitor variable INFLG is saved on the stack. INFLG tells AIM what the current input device is. Since the subroutine will change the

input device to audio tape, we have to be careful here not to lose track of input devices. The next task is to examine BASIC's symbol table to determine if A\$ has been defined as an 80 byte character string according to our design assumptions. In either case, the logic will proceed to a next lower hierarchical level. This is indicated by the next sets of

braces to the right. When control is returned back to the first level, INFLG is restored from the stack. Most often, this will again put the AIM in the keyboard mode. Finally, the subroutine passes a return code to BASIC. The 16 bit integer return code in registers A,Y (MSB, LSB) is given to BASIC by a JMP indirect to location \$B008 in the BASIC ROM.

Figure 2

```

K>*=7C00
/40
7C00 AD LDA A412      Save INFLG
7C03 48 PHA
7C04 A5 LDA 75        Start of BASIC's symbol table
7C06 85 STA F0
7C08 A5 LDA 76
7C0A 85 STA F1
7C0C A5 LDA 77        Reached end of symbol table?
7C0E C5 CMP F0
7C10 D0 BNE 7C24      No...
7C12 A5 LDA 78
7C14 C5 CMP F1
7C16 D0 BNE 7C24      No...
7C18 A0 LDY #FF       Error exit - set return code to -1
7C1A A2 LDX #FF
7C1C 68 PLA           Normal exit
7C1D 8D STA A412      Restore INFLG
7C20 8A TXA
7C21 6C JMP (B008)    Return to BASIC
7C24 A0 LDY #00
7C26 B1 LDA (F0),Y
7C28 C9 CMP #41       Have we found A$?
7C2A D0 BNE 7C33
7C2C C8 INY
7C2D B1 LDA (F0),Y
7C2F C9 CMP #80
7C31 F0 BEQ 7C40
7C33 18 CLC           Point to next symbol table entry
7C34 A5 LDA F0
7C36 69 ADC #07
7C38 85 STA F0
7C3A 90 BCC 7C0C
7C3C E6 INC F1
7C3E D0 BNE 7C0C
7C40 A0 LDY #02       Found A$...
7C42 B1 LDA (F0),Y    Get address and length of A$
7C44 99 STA 00F0,Y
7C47 C8 INY
7C48 C0 CPY #05
7C4A D0 BNE 7C42
7C4C A4 LDY F2

```


Assuming A\$ satisfies the design assumptions, the subroutine will set A\$ to blanks. This is done every time the subroutine is called. Next a counter which counts the number of data characters read is zeroed. Then a test is performed to determine if the subroutine is being called for the first time. (NOTE: the success of this test relies on the BASIC program to POKE location \$F5 to 0.) INFLG is next restored from a temporary variable at \$F6. The AIM

should now be configured to accept input from audio tape. So then the character read routine is called repeatedly until a carriage return is detected and processed.

If A\$ does not meet our design assumptions, the return code is set to -1. This should alert the BASIC program of an error condition.

If the subroutine is being called for the first time, the AIM subroutine

WHEREI is invoked. WHEREI issues the familiar prompt:

OUT =

Normally the user responds with "T". The AIM monitor will then prompt for the file name and tape drive number. When WHEREI finishes, INFLG, which was just set by WHEREI, will be stored in a temporary at \$F6. This completes the initialization sequence.

Figure 2 cont.

Figure 3

```

K>*7C4E
/40
7C4E C0 CPY #50      Is A$ 80 bytes long?
7C50 D0 BNE 7C18     No, then error
7C52 88 DEY          Yes, blank out A$
7C53 A9 LDA #20
7C55 91 STA (F3),Y
7C57 88 DEY
7C58 10 BPL 7C55
7C5A A5 LDA F5       Is it the first time called?
7C5C D0 BNE 7C66
7C5E 20 JSR E848     WHEREI
7C61 AD LDA A412     Store new INFLG in a temporary
7C64 85 STA F6
7C66 A0 LDY #00
7C68 A5 LDA F6       Restore INFLG from the temporary
                          variable
7C6A 8D STA A412
7C6D 20 JSR E993     INALL
7C70 C9 CMP #0A      Ignore line feeds
7C72 F0 BEQ 7C6D
7C74 C9 CMP #0D      Is it a CR?
7C76 D0 BNE 7C82     No...
7C78 C5 CMP F5       Was previous char a CR?
7C7A 85 STA F5
7C7C F0 BEQ 7C89     Yes...
7C7E A2 LDX #00      End of text line
7C80 F0 BEQ 7C1C     Return to BASIC
7C82 91 STA (F3),Y   Store the char in A$
7C84 85 STA F5
7C86 C8 INY
7C87 D0 BNE 7C68     Now go read the next char
7C89 A0 LDY #00      End of file...
7C8B AD LDA A434     Which tape drive are we using?
7C8E D0 BNE 7C9A
7C90 AD LDA A800     Turn drive 1 on
7C93 09 ORA #10
7C95 8D STA A800
7C98 D0 BNE 7C7E     Exit
7C9A AD LDA A800     Turn drive 2 on
7C9D 09 ORA #20
7C9F 8D STA A800
7CA2 D0 BNE 7C7E     Exit

```

LIST

```

10 POKE 245,0
20 AS = ""
30 FOR I = 1 TO 80
40 AS = AS + "*"
50 NEXT
60 POKE 4,0
70 POKE 5,124
80 L = USR(0)
90 IF L < 0 THEN STOP
100 IF L = 0 THEN PRINT
    "DONE"; END
110 PRINT LEFT$(AS,L)
120 GOTO 80

```

WARNING: Locations 4 and 5 must be POKed with the physical address of the machine language subroutine. In this program the subroutine is at \$7C00.

The read character routine calls a lower level read routine until a character other than a line feed is found. The purpose for skipping line feeds, is to facilitate the reading of BASIC source program tapes. (BASIC prefixes each source program line with a line feed.) One of two lower level routines is then invoked depending on whether the character just obtained is a carriage return or not.

The lowest level read character routine is simply an invocation of the subroutine INALL. INALL will obtain a character from the current input device.

If the character obtained is a carriage return, the previously read character is examined. If the current character is not a carriage return, the current character is stored in the next available byte of A\$ (pointed to

by \$F3 and \$F4). The count of the number of characters read is updated.

If the current and previous characters are both carriage returns, end of file has been detected. The proper tape drive is turned back on (INALL turned it off) so the tape can be rewound. Then the return code is set to 0.

If the current character is a carriage return, but the previous character was not, the end of a line has been reached. The return code is set to the count of the number of characters read. Note: the carriage return is neither counted nor stored in A\$.

μ

Tape Read Subroutine

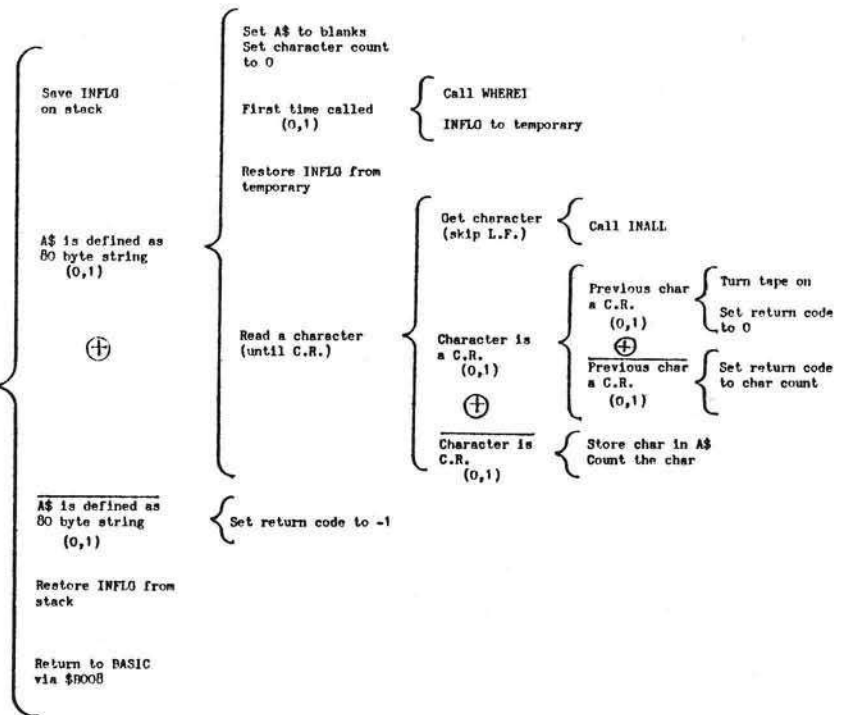


Figure 4

Christopher Flynn became interested in microcomputers when he assembled a MITS Altair computer kit in 1976. Since then, he has obtained a KIM-1 and an AIM-65. His KIM system interfaces to several S-100 boards by means of a KIMSI Motherboard.

The AIM is his favorite system. It has 32K of RAM and uses a Model 33 teletype for hardcopy output. His software interests include Assembly language and BASIC.

Applications developed on the KIM and AIM range from an interpreter to a home budgeting and accounting system. To support this hobby, Chris is employed by the Fairfax County government as a systems analyst for the county's tax systems.

Christopher's wife, Nancy, has learned to program in BASIC. Their two year old daughter, Becky, when asked what her father's name is, has been known to respond, "6-5-0-2".

Figure 5

SYMTAB	\$F0,\$F1	Pointer to BASIC symbol table
LEN	\$F2	Length of A\$
APNT	\$F3,\$F4	Pointer to A\$ in BASIC's memory
TEMP	\$F5	First time switch; hold area
TINFLG	\$F6	INFLG hold area

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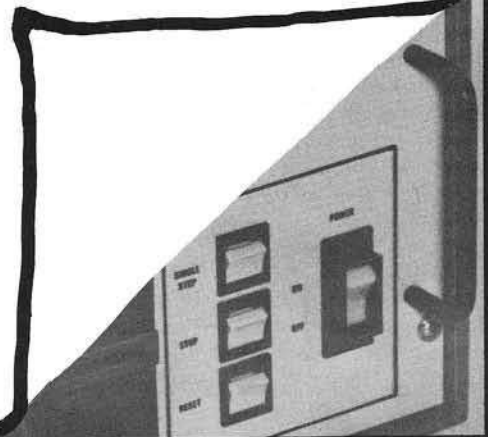
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Those of you who are listed please take a moment to make sure that the information is correct. Notify us of any errors. Up-dates should be sent to us periodically.

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Director, Computer Center
California State University
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90840

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Aggieland Station, TX
77844

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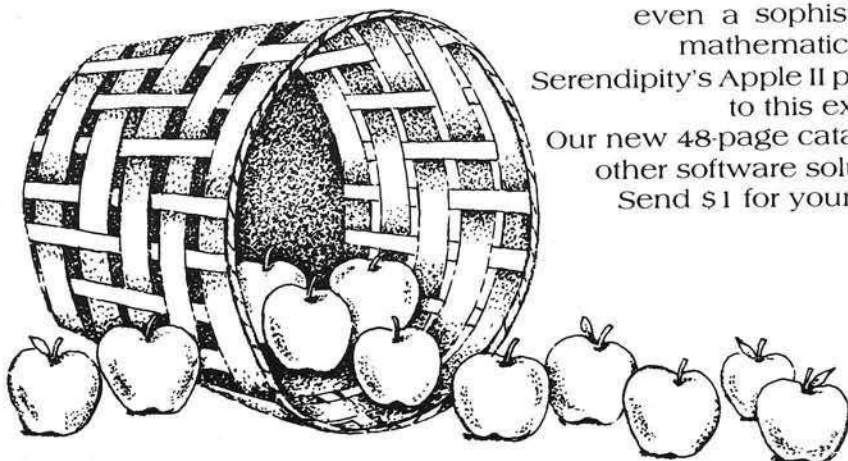
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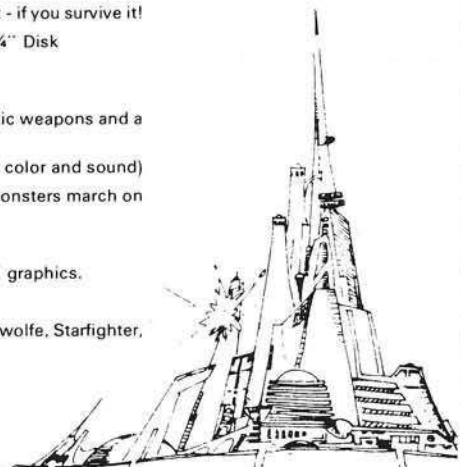
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The MICRO Software Catalog: XXII

Software announcements for the 6502 based systems

Mike Rowe
P.O. Box 6502
Chelmsford, MA 01824

Name: **ALGEBRA**
System: **PET 2001**
Memory: **8K or more**
Language: **BASIC, Machine**

Description: A series of 7 programs (on one cassette) designed to assist a student through various levels of the subject. Topics include: Set operations, signed arithmetic, linear equations, factoring, and quadratic equations. An example of each class of problem is given, followed by a changing sequence of problems to be solved by the student. After each problem, an answer is provided to check results. Other Pet software available.

Copies: **New Release**
Price: **\$19.95**
Author: **Len Bugel**
Available: **TYCOM Associates**
68 Velma Avenue
Pittsfield, MA 01201

Name: **Computer Station**
System: **Apple II or Apple II Plus**
Memory: **32K**
Language: **Integer Basic or Applesoft**
Hardware: **Apple II, Disk II**

Description: Program will copy a complete diskette using an Apple II with only a single disk drive. The program will function properly on an Apple II or Apple II Plus with or without the Applesoft ROM Card or the Language System. It will run with DOS 3.1, DOS 3.2, or DOS 3.2.1 and will run on either a 32K or 48K system. On a 32K system it will take five passes for a full diskette while only three on with 48K. Requires a maximum of 3 passes on a 48K system, does verification, will initialize if desired and is faster than Apple's two disk copy.

Price: **\$29.95, \$2.00 s&h**
IL residents add 5 %
sales tax.
Includes: **Diskette, pamphlet**
Author: **Joel Upchurch**
Available: **Computer Station**
12 Crossroads Plaza
Granite City, IL
62040

Name: **AMATEUR RADIO**
COMMUNICATIONS
PACKAGE
System: **Apple II, Plus**
Memory: **16K**
Language: **Integer**
Hardware: **Radcom Plus Card**
(supplied), Disk II

Description: Send-Receive RTTY and Morse Code. Interface installs in Slot 2. Active bandpass filters. FSK output. Narrow Shift (170 HZ). LED tuning indicators. Scope monitoring. Computer grade circuit board. Gold plated contacts. Assembled and tested. Baudot speeds continuous 32 to 300 Baud. ASCII to 1200 Baud. Morse Code speeds 2 to 125 WPM. Split screen, receive, Xmit and Xmit buffer. Save text from a buffer to the Disk. Load text from Disk to a buffer (TX/RX). Display current system status or catalog. Normal/Invert RTTY Rx key control. Stored messages to limit of RAM. Much more!

Copies: **Just released**
Price: **\$190.00**
Includes: **R a d c o m**
Plus = Card, Software on Disk, doc.
Authors: **Radcom Plus Card**
by Alex M. Massimo
AF6W
Software by Dr.
Chris H. Galfo WB4-
JMD
Available: **Alex M. Massimo**
4041 41st Street

San Diego, CA
92105

Name: **The Creativity Life**
Dynamic Package
System: **Apple II**
Memory: **48K**
Language: **Applesoft, Machine**
Hardware: **Apple II, Disk II**

Description: Draw, Write Music, Write Poetry! Draw Circles, ellipses, triangles, frames, enclosures, fireworks, squares, etc. (many more!) all at the touch of a key or two (without hitting return). Fill or partially fill any of the above figures to create an infinite variety of figures. Change to and from Regressive & Symmetry Modes. Write Music using your keyboard like a piano. Watch your notes be named and written on a cleff. Easily change pitches and durations. Write a poem. Choose 1, 2, or 3 forms, save and play later! MUCH MORE!!

Copies: **Many**
Price: **\$19.95**
Includes: **Disk, 88 page Prog.**
Manual, 2 drawing
cards.
Author: **Avant-Garde Crea-**
tions
P.O.Box 30161 MCC
Eugene, OR 97403

Name: **GAF Software Utili-**
ty Packages 1 & 2
System: **Apple II, Plus**
Memory: **32K**
Language: **Integer, Applesoft**
Hardware: **Apple with Disk II**

Description: A collection of useful utility programs. Utility 1: File Compare, a program that allows comparing of two versions of a program and reporting all differences to you

screen, printer, or disk file. Menu, a general purpose HELLO program that allows one keystroke program execution. Reads any size catalog to produce menu. Applesoft & Integer Sorts, fast implementation of Shell-Metzner sort can be adapted to your programs. Convert-To-Text, turns Applesoft and Integer programs into text files. Utility Package 2 includes Multiple Disk Catalog, File Cabinet Fast Sort, File Copy and Food Plan.

Copies: **Just released**
 Price: **\$30.00 each**
\$50.00 both
 Author: **Gary A. Foote**
 Available: **GAF Software**
 127 Mt. Spring Road
 Tolland, CT 06084

Name: **LCMOD for Pascal**
 System: **Apple**
 Hardware: **Apple Language System**

Description: Allows DIRECT entry of upper/lower case into the Pascal Editor using the Paymar LCA. Uses the ESC key for a shift key and the ESC key is now a Control Q to prevent accidental deletion of text. Also provides generation of left and right curly brackets for comment delimiters and an underline for VARs, program names and file names.

Price: **\$30.00**
 Available: **Southeastern Software**
 7270 Culpepper Drive
 New Orleans, LA 70126

Name: **MAG Files**
 System: **Apple**
 Hardware: **Disk II**

Description: Having trouble keeping track of all those magazine articles you read? Here is the answer. Enter them once and use the search modules to find them again either by title or subject code. Requires Applesoft II.

Price: **\$18.00**
 Available: **Southeastern Software**
 7270 Culpepper Drive
 New Orleans, LA 70126

Name: **Bad Buy Diskette**
 System: **Apple**
 Hardware: **Disk II**

Description: Of course it is a bad buy. If you had issues 2 through 11 of the Southeastern Software NEWSLETTER, you could type these programs in yourself. They are a mix of Integer, Applesoft II and assembly language programs and utilities.

Price: **\$9.99**
 Available: **Southeastern Software**
 7270 Culpepper Dr.
 New Orleans, LA 70126

Name: **Double Precision Floating Point for Applesoft**
 System: **Apple II, Plus**
 Memory: **32K**
 Language: **Assembly Language. Use with Applesoft Programs.**
 Hardware: **Disk II**

Description: Provides 21 digit precision for Applesoft programs. Arithmetic expressions, as well as INPUT and PRINT are supported. Applesoft subroutines for the standard math functions are included. Nearly standard syntax is used, with the ampersand feature. Efficient and compact, only 2048 bytes. Loads itself beneath your Applesoft prog. Works with Applesoft ROM card, with Applesoft in the Language System, or with RAM Applesoft.

Copies: **25**
 Price: **\$50.00**
 Includes: **Diskette, Reference Manual**
 Author: **Bob Sander-Cederlof**
 Available: **S-C Software**
 P.O.Box 5537
 Richardson, TX 75080

Name: **Letter Perfect**
 System: **Apple II, Plus**
 Memory: **Min. 32K**
 Language: **Machine**
 Hardware: **Apple II, Plus/ 32K min/ Dan Paymar Lower Case.**

Description: A character orientated word processor. It supports propor-

tional spacing and is capable of working with any printer type. It is user orientated and menu driven. Complete documentation. Supports: global and local searches, complete formatting, full ASC II character set with lower case on video display, headers, footers, page numbering, complete formatting within body of text, top margin, and much more! Full cursor control.

Author: **Kenneth Leonhardi**
 Available: **LJK Enterprises, Inc.**
 P.O.Box 10827
 St. Louis, MO 63129

Name: **Gus's Disk Utility**
 System: **Apple II**
 Memory: **16K, 32K, 48K**
 Language: **Machine**
 Hardware: **Apple II, Disk II**

Description: Program is designed to be an easy to use aid to working with the Apple II DOS 3.1 or DOS 3.2. Restore those accidentally deleted files, remove DOS from your diskette for more room on your data only disks, read/write to any sector, print file attributes (catalogs your disk and allows to choose any file on the diskette to give you file type, track sector list, the sector lists which contains your program), prints binary program parameters, and will map the free sectors of your diskette. Allows individual byte or sectors to be changed or transferred to another diskette.

Copies: **Just released**
 Price: **\$45.00**
 Author: **Ralph D. Gustafson**
 Available: **Rainy City Software**
 4360 SW Parkview
 Portland, OR 97225

Name: **Disk Apple II Report Textwriter -DART**
 System: **Apple II Or Apple II Plus**
 Memory: **32K**
 Language: **Applesoft II**
 Hardware: **Disk II, optional printer and lower case adapter**

Description: A program which composes reports, articles, letters and other documents, utilizing text files generated by the "DOS Text Editor". Text may be input in free form format, without regard to line length or pagination. Retrieves the data from

the file, formats it into lines of desired length, and displays it on a printer or Apple CRT. Changing the text requires only that the text file be modified with EDIT-II, and DART called to format and output a new report. The variable input function allows form letters and standard text to be modified from the keyboard to produce custom letters and reports. File chaining allows an unlimited amount of input text.

Price: **\$19.95 plus \$1.25 s & h. Package special: EDIT-II and DART \$37.89**

Copies: **Just released**
Includes: Diskette, user manual, and documentation

Author: **Robert Stein**
Available: Services Unique, Inc.
2441 Rolling View Dr.
Dayton, Ohio 45431

Name: **Disk Text Editor- Edit II**
System: **Apple II or Apple II Plus**

Memory: **Minimum 24K**
Language: **Applesoft BASIC**
Hardware: **Apple, disk and optional printer and lower case adapter.**

Description: An improved version of the DOS Text Editor, designed to create and facilitate changes to disk files, reports, lists, etc. Also supports the cassette as a file device. Includes 35 commands. String commands allow searching, changing, and listing of single records or blocks of records for a specified word or phrase. User input. File commands merge input from various files, parts of files and text buffers. Handles full upper and lower case output to print devices. Works with DART.

Copies: **Over 200 of Edit-I**

Price: **Cassette \$19.95
Diskette \$23.95
Shipping \$1.95**

Includes: User manual and documentation

Author: **Robert A Stein, Jr.**
Available: Apple Computer Stores or Services Unique, Inc.
2441 Rolling View Dr.
Dayton, OH 45431

Name: **Program Writer**
System: **Apple**
Memory: **32K minimum**
Language: **Applesoft**
Hardware: **1 Disk Drive**

Description: This program was written to speed up the process of writing advanced business program. It works as a data management system, but also writes disk statements as permanent line number, if requested. Supports 20 fields per entry, searching or sorting by any field, generating reports, packing numbers to increase disk space, plus many more. Use for inventory, checks, phone numbers, etc. Simple to use with instructions.

Price: **\$29.95**
Copies: **Just released**
Includes: Diskette, instructions, examples

Author: **Wilford Niepraschk**
Available: Wilford Niepraschk
5921 Thurston Avenue
Virginia Beach, Va 23455

Name: **Visible Memory Routines**
System: **8K PET**
Memory: **2K**
Language: **Machine Language**
Hardware: **8K PET, MTU Visible Memory Board**

Description: Machine language software easily accessible by BASIC. Package includes clear screen, plot-a-point, line draw, and ROSE plotting programs. Other programs available to run with VM Routines: VM LISS-3D space Art, VM Spirals, Hi-resolution spirals, VM 3D Plots, same 3D images as seen in many ads. More coming. Send SASE for list of these and other programs. Copies of MTU user's Notes available.

Copies: **Just released**
Price: **\$7.95 for VM Routines**
Includes: Cassette, Documentation

Author: **Russell A. Grokett, Jr.**
Available: Pet Library
401 Monument Road
Jacksonville, FL 32211

Name: **PSA/1**
System: **Apple II, Plus**
Memory: **16K**
Language: **Applesoft Basic**
Hardware: **Apple II (Printer, opt)**

Description: A cassette-based introduction to computer scheduling. Using critical-path scheduling techniques, it allows the user to define a project, input time estimates for each job in the project, and then compute schedules for each job. Computes the earliest and latest each job can be started, finished, in order to meet deadlines. Also schedules delays without harm to other jobs. Displayed on video.

Copies: **New Release**
Price: **\$25.00 (WA add 5 %)**
Includes: Cassette, User Manual
Author: **Don Taylor**
Available: Express Marketing
21866 Clear Creek Road
P.O.Box 1736/MSC
Poulsbo, WA 98370

Name: **Files**
System: **Apple II 3.2 or 3.2.1 DOS**
Memory: **32K min.**
Language: **Applesoft**
Hardware: **Disk necessary, Printer optional**

Description: File is a modular File utility program which is designed to allow the user to build files, add to existing files, correct records, delete, lock, unlock, insert records, move records, delete records, find records, sort, append files together, rename and save files, and view file data.

Copies: **Just released**
Price: **\$49.95**
Includes: Disk and manual
Author: **Marc Goldfarb**
55 Pardee Place
New Haven, Conn. 06515

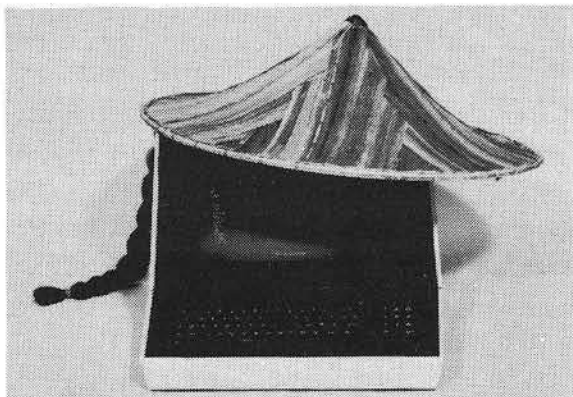
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*While we have been lenient in the past regarding the length of the entries in the Software Catalog, we must now insist that future entries be kept as brief as possible. We think that twelve to fifteen lines in the "description" part of the entry should keep it about right. The other parts, as long as needed.*

*We now have so many entries backed up, that we feel this policy is only fair to give everyone 'equal time'. We will be forced to edit, or return any entries that we judge too long.*

*Mike Rowe*  
~~~~~


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Computers & Gambling Magazine

PRESENTS: PROBABILITY HANDICAPPING DEVICE I

A 16K BASIC PROGRAM FOR: HORSE RACE HANDICAPPING!

This amazing program was written by a professional software consultant to TRW Space Systems and is being introduced by the publishers of Computers and Gambling Magazine. "PHD-1" is a large complex basic program requiring a full 16K. It is carefully human factored for easy use. PHD-1 is a comprehensive horse racing system for spotting overlays in thoroughbred sprint races (less than 1 mile). You simply sit down with your computer and the Racing Form the night before the race and answer 5 or 6 questions about each horse's past performance. Your computer then accurately predicts the win probability and odds-line for each horse allowing you to spot overlaid horses while at the track. The users manual contains a complete explanation of overlay betting.

Statistics for thousands of horses were used to develop this handicapping system. The appendix of the manual contains a detailed tab run of a 100 consecutive race system workout showing an amazing 45% positive return (45¢ for each \$1.00 wagered). A graph is also included showing PHD-1's close fit to the ideal predicted probability vs. actual win percentage curve.

This program features: ☐ Win probability and odds for each horse ☐ Verification display of each horse's parameters prior to entry for easy error correction ☐ Bubble-sort routine for final display ☐ Facility for line printer output ☐ Cassette ARCHIVE routine to store PHD-1's output for later analysis ☐ Complete users manual.

The user's manual may be ordered separately for your perusal for \$7.95 and will be credited if you purchase PHD-1.

PHD-1 User's Manual and 16K Cassette for:
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6502 Bibliography: Part XXII

Continuing bibliography of 6502 related material

Dr. William R. Dial
438 Roslyn Avenue
Akron, OH 44320

642. Appleseed (Softside) (Jan. 1980)

Micklus, Lance and Summers, Murray, "Dog Star Adventure," pg. 36-48.
Rescue the Princess Leya.

643. Creative Computing 6, No. 1 (Jan. 1980)

Howerton, Christopher, "Grandapple Clock," pg. 104-107.
Now your Apple can tick, chime, and keep time.
Carpenter, Chuck, "Apple-Cart," pg. 134-137.
Discusses Keyword search, the MOD function, New Apple products, etc.
Yob, Gregory, "Personal Electronic Transactions," pg. 148-150
Discusses short utility routines, a programming for formatting numbers, etc.

644. SYM—PHYSIS, Iss. 1 (Jan/Feb. 1980)

Anon., "2KSA Assembler/Editor," pg. 3-6.
Assembly language program for the Sym-1.
Anon., "Relocate for the SYM-1," pg. 7-12.
Machine language program for the Sym-1.
Gettys, Thomas, "MERGE/DELETE Program for SYM Basic," pg. 13-16.
Utility routine.

645. Apple 1, No. 3 (1979)

Willson, Dr. M. Joseph, "The Challenge to Personal Computers in Science and Industry," pg. 2-5.
The Apple II will be on board the Space Shuttle where it will monitor scientific experiments.
Anon., "Applications of the Apple," pg. 7-18.
Discussion of a number of applications including evaluating paramedic and hospital procedures, endocrine levels in the birth process, Pascal in Education, testing telephone lines, use in the trucking industry, prospecting by computer and use in military games in "think tanks."

646. Recreational Computing 4, No. 1 (Jan. 1980)

Mulder, David, "Merging on the PET," pg. 40-41.
Put two programs together with this routine.

647. Recreational Computing 8, No. 1 (Jan/Feb 1980)

Hall, David J., "Computing for Health and Equality," pg. 8-11.

DAII about Holistic Health and the PET.

Deliman, Tracy, "Holistic Computing - A Program Idea for Healthy Living," pg. 12-14.

A PET oriented program on holistic health.

Thornburg, David D., "The Presto-Digitizer Tablet," pg. 16-18.
A low cost alternative to data entry keyboards.

Sevik, Jim and Eric, "A Learning Program for Problem Readers," pg. 25-28.

A PET Program for readers with reading problems.

648. Kilobaud Microcomputing No. 37 (Jan. 1980)

Anon., "Ohio Scientific's Small Systems Journal," pg. 10-13.
Discusses the OSI-DMS Quotation/Estimation System, the Educational System, Inventory Control, Purchasing System, and Bills of Material System.

Baker, Robert W., "PET Pourri," pg. 14-16.

Discusses New Pet Products, Axiom Printers, Programming Ideas and Tips.

Schmeltz, Leslie R., "'Core' and More for Your Apple," pg. 110-114.

Accessories for your Apple.

Freeman, Robert, "The Metamorphosis of a 'Custom' PET," pg. 116-118.

Customize your PET.

Knapp, Jeff, "Darkroom Master," pg. 126-130.

Use your PET in the Darkroom.

649. Stems From Apple 3, Iss. 1 (Jan. 1980)

Stein, Dick, "PASCAL Time," pg. 7-14.

Three example programs which either reads or writes a data file.

650. Kilobaud Microcomputing Iss. 38 (Feb. 1980)

McCormack, Chris, "Microchess Modifications," pg. 68-69.
Enhance this game for your KIM.

Ramsey, David, "Two Intriguing and Useful Apple II Peripherals," pg. 70-74.

Getting to know Speechlab and Apple Clock.

Sparks, Paul W., "Development of a Text-Handling Program: A Learning Experience," pg. 112-118.

Handling words on the PET.

Martellaro, John, "Apple's Hidden Floating-Point Routines," pg. 132-135.

Lightning-fast number crunching.

Spisich, John, "Add a Digital Tape Index Counter to the PET," pg. 158-160.

Construct this counter for your PET cassette and locate files quickly and accurately.

Blalock, John M., "A Printer for the KIM or SYM," pg. 186-192.

The Selectric finds another home.

651. Creative Computing 6, No. 2 (Feb. 1980)

Zimmerman, Mark, "Blackbox for the PET," pg. 112-117.
A game with graphics.

Carpenter, Chuck, "Apple-Cart," pg. 148-151.

Hints on using diskettes, Apple I/O Circuits, tips on using Pascal, Applesoft formatter.

652. The Target (Jan/Feb. 1980)

Bresson, Steve, "CHAIN," pg. 6-7.

Controlled loading and execution of multiple files from tape on the AIM 65.

653. Call—Apple 3, No. 1 (Jan. 1980)

Spurlock, Loy, "Creating a Hi-Res Character Set," pg. 13-15.
A Basic program for creating characters.

Hyde, Randall, "Assembler Maxi-Reviews," pg. 18-23.

Reviews of the Microproducts Assembler, the SC-Assembler II, ASM/65, EAT (Edit and Assemble Text), LIZA, UCSD Adaptable Assembler (Pascal).

Konzen, Neil, "ZOOM," pg. 28-32.

Two versions: one for Basic and one in assembly language.

654. MICRO No. 21 (Feb. 1980)

Peck, Robert A., "Expanding the SYM-1...Adding an ASCII Keyboard," pg. 5-7.
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